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AUTHOR	Tisher, Richard P.; Power, Colin N.
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ABSTRACT

This project was concerned with the effects of teaching activities in lessons where self-paced materials were used; with associations between teaching activities and cognitive and affective outcomes; with relationships between teachers' beliefs about teaching and teaching activities and pupil outcomes; with pupils' perceptions about a self-paced learning environment; and with associations between pupils' perceptions and observed teaching activities and outcomes. Data were obtained from 20 classes containing 326 pupils; 12 of these classes were taught by student teachers and 8 by experienced teachers. The classes of the student teachers were allocated to four different treatments: (1) use of Australian Science Education Project (ASEP) materials only; (2) ASEP materials plus a pre-structuring teacher overview and a film; (3) ASEP materials with mid-structuring lessons and the film; (4) ASEP materials plus post-structuring and the film. The eight experienced teachers used ASEP materials but were not assigned to treatments. Students were given attitude and achievement pre- and posttests. Forty lessons were videotaped and analyzed. Results are discussed in terms of the nature of the learning environment, variation in the environment of the classrooms, and the teachers' structuring behaviors. (DT)

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The Effects of Classroom Activities, Pupils' Perceptions, and Educational Values in Lessons where Self - Paced Curriculum Materials are used.

Richard P. Tisher
Faculty of Education
Monash University

and

Colin N. Power
Faculty of Education
University of Queensland

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1975.

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1. INTRODUCTION

1.1 Background to the Study.

During the past 20 years a great deal of money and effort has been expended in the development of new curricula. In a number of instances these curricula have appeared as "package deals" with pupil and teacher guides, laboratory manuals, record books, ancillary reading guides and the like. Furthermore, many of the materials were designed to cater, as adequately as possible, for individual differences among learners and to foster growth towards a variety of educational objectives. For example, a number of science curricula were designed to develop pupils' inquiry skills, understanding of the inter-relationships between the separate sciences and their impact upon society, and knowledge of basic scientific facts. In Australia, the Australian Science Education Project (ASEP) incorporated many of these preceding features which were characteristics of the newer curriculum materials into its curriculum units. One important feature of the ASEP materials is the emphasis given to individual activity by the learner who is encouraged to work through the materials at his own pace. Essentially the ASEP materials are self-paced curriculum materials which can be expected to have an impact on classroom dynamics and the development of pupils' understandings of science. This study is concerned with the nature and variety of teaching activities which occur in lessons where the ASEP self-paced materials are used and with the effects of these activities. The project is substantially a replication of an earlier study (Tisher and Power, 1973) but it does contain a number of different features, for example, a different curriculum unit was used in the lessons, and additional perception measures were administered to pupils. More detailed discussions of these features occur in subsequent chapters of this report.

It is appropriate to note that the nature of this project has been influenced by a number of factors including our previous experiences in studies of classroom interaction, our involvement in programmes for the pre-service education of teachers and our association with the implementation of the ASEP materials. Our earlier studies dealt with the associations between teacher behaviours and pupil outcomes (Power, 1971; Tisher, 1970) and many significant and interpretable findings were obtained. However, as a consequence of our experiences we became convinced that studies of teaching and learning had neglected to include a variety of important features in the research design. Certainly when our findings and those of many other researchers are summarized and categorised (c.f. Brophy and Good, 1974; Dunkin and Biddle, 1973) the net result of the research effort appears somewhat disappointing; due, we believe to the failure to include a number of significant variables and to inappropriate research procedures. These comments are not meant to imply that we adopt the extreme point of view expressed

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by Heath and Nielsen (1973, 1974) who argue that studies of the teaching-learning process are well-nigh useless. Teaching does make a difference and does influence learning by pupils. Teaching is a most pervasive activity in our societies, and as such demands intensive and extensive study. That the pay-off from previous research has been small is not necessarily a reason to abandon all efforts, in fact, as Nuthall (1973) suggests, it provides a challenge to continue with the research and, too, to search for new research genres. We believe research on the teaching-learning process is extremely difficult and complex and requires the dedicated, continued attention of researchers if major break-throughs are to occur. We also believe that there have been a number of benefits from preceding studies. For example, teachers and educationists now have a more adequate and appropriate vocabulary to describe classroom activities, a greater awareness of the nature and variety of these classroom activites, a greater understanding of the variety of effects of these activities, and techniques such as micro-teaching, guided self-analysis and other classificatory schemes for use in teacher education programmes. There is in fact much accumulated wisdom which a number of writers (e.g. Dunkin & Biddle, 1973; Flanders & Simon, 1969; Rosenshine & Furst, 1971) have begun to sift and synthesize. But, much of this wisdom has been acquired from studies of more formal classroom settings rather than self-paced or "open" classroom settings. Thus, there is a need to add knowledge gleaned from studies concerned with teaching and learning in classrooms where self-paced curriculum materials are used.

Furthermore, with the advent of a greater number of open classrooms, and the increased emphasis on inquiry skills in education programmes, there is an urgent need to study the nature and effects of the teaching activities in the "newer" educational environments. Westbury (1973) states that there are no clear guidelines or strategies for teachers to show how they might maintain open classrooms as viable learning environments;

> "we are not given any sort of concrete strategies
> that tell us how the involvement of many students
> in tasks is sustained, how involvement is actually
> transformed into mastery of a conventional (or even
> unconventional) kind, or how the teacher manages the
> series of simultaneous learning settings that are
> implicit of open classrooms" (p.111)

If this is the case, then a great deal of research is needed on these settings so that more adequate advice can be given in teacher education programmes. But there is an immediate difficulty - one which we encountered in our earlier study of classes where self-paced curriculum materials were used. In these more "open" or self-paced learning settings the well-established classifactory schemes of Bellack(1966), Flanders (1967) and Smith and Meux (1962) are not entirely suitable. Newer coding schemes which incorporate some of the elements of the preceding three are required. However, these schemes must be "conceptually linked" to the more open learning environment, that is, they need to take .....

account of group and individual activities as well as interactions between pupils and materials, teachers and other pupils. We have devised a special coding scheme for this study and a detailed description appears in Appendix A.

In some of the previous research studies on teaching the experimenters used standardised achievement tests to obtain measures on pupil growth, and were not able to obtain a high degree of control over the teaching-learning situation. Both of these features have been criticised by Rosenshine and Furst (1972) who maintain that

(a) curriculum packages which contain definite learning sequences and teaching strategies should be used in research studies since they will control the range and nature of the classroom activities, and

(b) mastery or criterion referenced tests should be used in preference to standardised tests. The criterion-referenced tests can be developed quite readily when curriculum packages are used.

We concur with Rosenshine and Furst's point of view. In this study criterion-referenced tests, based on one unit from the ASEP materials, were designed by the researchers, teachers and teacher trainees. Also, the particular ASEP unit, "How Many People", contained clear directions for pupils and served as a control on classroom activities. There was an additional pay-off as well. Because we involved teacher-trainees and teachers as experimental teachers, test-constructors and test-markers, a large number of persons was introduced to the new ASEP materials, and to procedures for using them in schools. These persons also sparked off many discussions in school staff-rooms with one net result; information about ASEP was disseminated widely. But, even though we disseminated much information about ASEP and its "educational philosophy" and even though the curriculum materials exercised some control over the teaching-learning activities in classrooms, it is not the case that all teachers employ them in identical ways. A teacher's beliefs about effective teaching practices affect the manner in which he uses curriculum materials (c.f. Grobman, 1968; Tisher & Power, 1973). If newer curriculum materials such as ASEP are to have an impact on educational practice and are to be adopted by a great number of teachers, it is essential, we believe, to have as much information available as possible on the associations between teachers' beliefs, their manner of implementing ASEP-type materials, and pupil outcomes. This information will be extremely useful for teacher educators, including curriculum innovators and in-service course leaders. In this study we have taken account of teachers' beliefs and the associations between these and classroom activities in an attempt to provide useful information for teacher educators and teachers.

....

Our experiences in previous studies and our reviews of the research literature convince us that as many variables as possible should be included in research on the teaching-learning process. Also, the determinants of classroom behaviour should be sought more often in the characteristics of the teaching-learning context and in the interactions between these characteristics and individual traits and abilities. Several writers (Cohen, 1972; Mitchell, 1969) express a similar point of view and argue, as Power (1970) has done, that person-environment interactions are a *sine qua non* in all teaching-learning research. An attempt is made in this study to examine the effects of a number of these interactions. Multivariate procedures are employed in the task in the hope that the "pay-off" in the research will be greater than if univariate procedures were used solely. A number of writers (e.g. Power, 1970; Soar, 1969; Walberg, 1972) who have used the techniques in more formal class settings believe that greater "pay-off" does occur, but whether this is the case in educational settings where self-paced materials are used remains to be seen. Certainly there are more difficulties with sampling behaviours and with obtaining representative sets of class and group behaviours.

It has been indicated elsewhere (Tisher & Power, 1973) that only a few research studies have attempted to take account of the psychological significance which classroom events have for pupils or teachers. The conventional classroom classificatory schemes certainly do not do this since they are designed to be used by external observers, i.e. persons who do not usually belong to the classroom setting being studied. One way to gain the necessary information is to interview pupils and ask them to express their views about the significance and nature of classroom events. This method is extremely time-consuming and that is why few research workers have added the information to their ecological data. Another way, albeit a more limited procedure than the interview technique, is to require pupils to respond to a questionnaire which contains a number of items to which he can express agreement or disagreement. Several workers have done this (e.g. Anderson, 1970; McKeachie et.al, 1971; Walberg & Anderson, 1968) and have been able to associate several of the pupil perception measures with measures of pupil growth. In this study we have attempted to avoid the limitations in those earlier studies which failed to consider pupils' perceptions of their learning environments by administering two questionnaires which give valuable information on the nature of the classroom context from the pupils' viewpoint. Details about these instruments appear in subsequent chapters. Also, as a consequence of our earlier experiences with one of the questionnaires we became curious about the congruence or otherwise between pupils' perceptions of their learning environment and the picture of that environment obtained by using classificatory schemes. In this document we report on the congruences between the information obtained from the two procedures.

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1.2 Aims, Research Questions and Research Paradigm.

The preceding preamble describes some of the factors which have influenced our thinking about classroom research and, in particular about the nature of this study. As indicated in the previous section this project is concerned with the effects of teaching activities in lessons where self-paced curriculum materials are used. But, it is also concerned with sets of related issues including the following:

- what associations are there between teaching activities and cognitive and affective outcomes?
- what relationships exist between teachers' beliefs about teaching and (i) teaching activities and (ii) pupil outcomes?
- what is the nature of pupils' perceptions about a self-paced learning environment?
- what associations are there between pupils' perceptions and (i) observed teaching activities and (ii) pupil outcomes.

Note that the preceding questions which were posed in our previous study (Tisher & Power, 1973) were repeated here so that additional information would be obtained in answer to the questions. The present project is thus, partly, a replication of our earlier work. Note, too, that the preceding questions are appropriate ones for curriculum evaluation. Dunkin and Biddle (1973) maintain that questions, such as the preceding ones, are particularly relevant for curriculum research. In particular they state:

> "Curriculum developers need to ask themselves three questions ..
> 1) Do different teachers implement the curriculum in the same way?
> 2) Are the experiences provided consistent with the aims of the curriculum? and
> 3) Do these experiences induce the desired effect in pupils?
>
> All of these questions are related to classroom research, of course. Unfortunately, none is adequately researched in most programs of curricula innovation." (p.25)

Our questions about the nature of teaching activities, pupils' perceptions, and the associations between these and outcomes will also provide answers to the three preceding questions. Our project, then, could be considered to have an ancillary purpose to evaluate aspects of the ASEP materials.

In order to provide a concise picture of the factors we wish to study, we have developed a research paradigm which is suitable for learning contexts where self-paced curriculum materials are used. This paradigm, which is presented in figure 1, has been derived from findings from our earlier studies, and the reports of other researchers who have studied the effectiveness of various teaching strategies. The paradigm contains the same elements as the one presented in a previous report (Tisher & Power, 1973) but the lay-out differs.

....

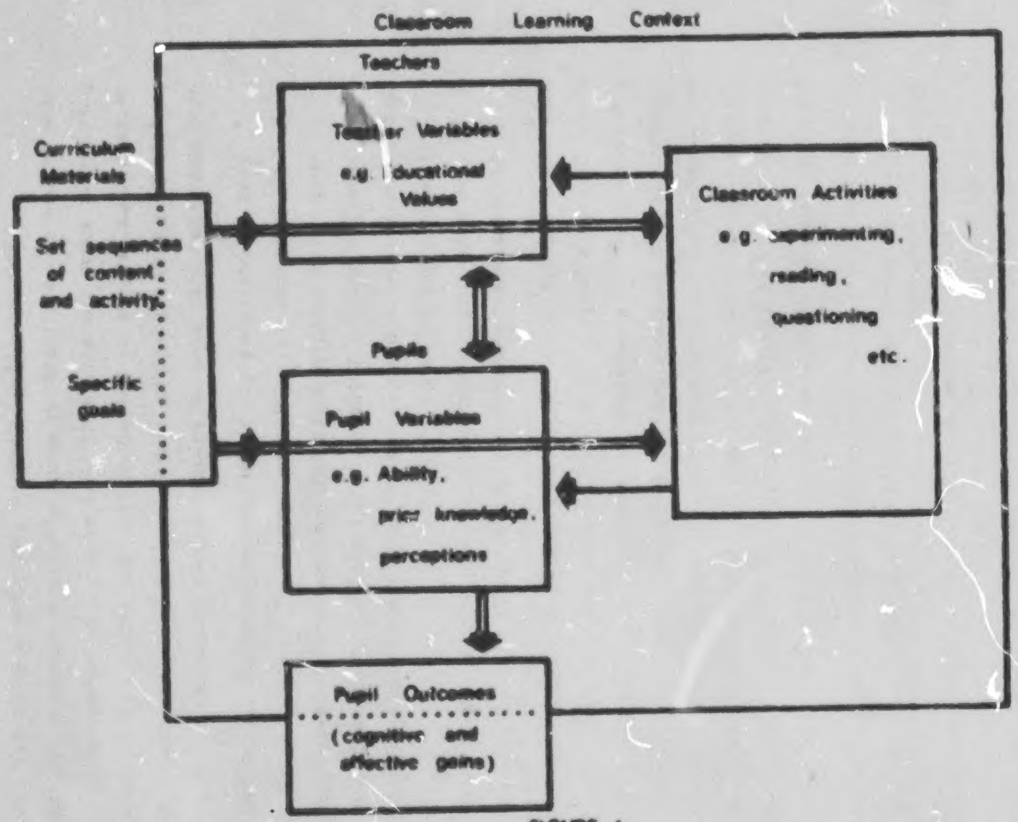
Classroom Learning Context
Teachers
Teacher Variables
e.g. Educational Values
Curriculum Materials
Set sequences of content and activity
Specific goals
Classroom Activities
e.g. experimenting, reading, questioning etc.
Pupils
Pupil Variables
e.g. Ability, prior knowledge, perceptions
Pupil Outcomes
(cognitive and affective gains)

FIGURE. 1

THE RESEARCH PARADIGM

The diagram is drawn to show a number of the chains of influence in a teaching-learning situation where self-paced curriculum materials are used. First, but not necessarily foremost, the curriculum materials exert their influence on the learning context. These materials are designed to meet specific educational objectives, are intended to display a range of scientific content and to guide the manner in which the pupils are permitted to proceed at their own rate. Second, the diagram shows that the influence of the curriculum materials will be modified to various degrees by teacher and pupil variables and the interaction between these two last mentioned factors. Teachers' beliefs about what constitute the most effective classroom procedures are one of the most potent set of factors which can modify the procedures advocated by curriculum materials, i.e. teachers' beliefs modify the manner in which self-paced units are used in classrooms. Similarly, pupil characteristics such as prior experience with self-paced materials, ability, prior knowledge in science and perceptions of the learning environment act as "filters" on the materials and modify the nature of the influence exerted by the materials on the classroom activities and the extent to which learning occurs. Of course there are a variety of contextual variables, such as administrative patterns, restrictive school rules, availability of physical facilities, which can influence pupils' perceptions of their total learning environment, and what happens in classrooms. We recognise this, but due to time restrictions and the extent of the demands which we believed we could reasonably place on schools, we did not study the effect of these extra-classroom contextual variables.

Thus curricula, teacher, pupil and contextual variables together shape the nature of classroom activities which in turn are associated with pupil outcomes, as the diagram shows. Now we have attempted to discover what are the natures of the various associations and our findings are reported in subsequent chapters. We began the study with several preconceived notions, however. First, we reasoned that teachers whose educational beliefs (values) were congruent with those embodied in the ASEP materials would be more likely to operate in learning environments where there was a great deal of enquiry and where pupils would make the greatest gains on ASEP oriented criterion measures. Second, we reasoned that the pupils in these particular classrooms would perceive their learning environment as a satisfying and rewarding one - more so than those pupils whose teacher had educational values which were dissonant with those of ASEP. The extent to which the data supported these preconceived ideas and the findings of our earlier study (Tisher & Power, 1973) are reported in a later chapter.

1.3 Research and Instructional Practice.

The present study was designed to eliminate many of the limitations possessed by a number of previous researches on teaching, e.g. greater "control" of classroom activities was obtained by using a curriculum package and the criterion tests were based on the content and skills employed in the particular package. At the same time we planned our project in such a way so as to avoid the perennial indictment from teachers that educational research has little effect on practice. Note, we do not accept the statement that educational research has had NO impact on practice. This is clearly not so! Research findings do filter through to practitioners, albeit slowly, and they are having an ever increasing, cumulative influence on teaching. However, to increase teachers' awareness of the contribution which research can make to practice, and to disseminate information as rapidly as possible, we involved a number of teachers and teacher-trainees in our project. As we indicated in section 1.1, as many persons as was practically possible were used as experimental teachers, test markers and coders for the video-tape analyses. Thus, a number of practitioners and trainees knew a great deal about the nature of our study and about the nature of the ASEP materials. The benefits which accrued from this involvement in the project were not checked rigorously. Nevertheless, we accumulated some anecdotal evidence that our scheme was successful. Teachers, and teacher-trainees commented often on the satisfaction they had experienced by being involved in research, and on the knowledge and research skills they had acquired. Also, in several schools, teachers who were not directly involved in the study became intrigued by our activities and tried out the ASEP materials we placed in their schools. Some trialled other ASEP units. The Diploma in Education students appeared to become more satisfied with teaching as a profession, and more appreciative of their training programme as a viable preparation for teaching.

2. METHODOLOGY

2.1 Preamble

This chapter contains a description of the procedures and instruments used in the project. In a number of instances the descriptions of the instruments are brief as the complete questionnaire or coding manual is reproduced in the appendix. As indicated in the previous chapter the study was designed to examine the effectiveness of teaching activities in lessons where the Australian Science Education Project (A.S.E.P.) materials were used. These materials were designed to encourage group and individual work, and independent inquiry. In this particular study teachers and teacher-trainees used the core section of the A.S.E.P. unit "How Many People". The complete unit consists of a "core" plus a set of optional activities. The teachers' handbook recommends that approximately 7 hours be devoted to the core and 25 hours to the six optional activities. The unit is about

> 'the interaction of man with his environment and the possibilities of increasing numbers of people interfering with the cyclic nature of the balanced global ecosystem upon which man's survival depends'. (Teachers' Handbook p.(ii)

It differs from many of the earlier A.S.E.P. units in that there is not a 'traditional' body of scientific knowledge to be mastered and in the fact that there is an attempt to influence pupils' attitudes regarding environmental conditions. Some of the intentions of the designers of the unit are expressed in the Teachers' Handbook as follows

> "After working through the unit, student will:
>
> 1. be concerned with problems related to population size, both human and other, and in particular with problems involving the relationship between human population size and
>   (i) the effect on the cyclic nature of the earth's ecosystem;
>   (ii) the quality of life generally.
> 2. also realize that each person is, in part, responsible for what occurs in the environment, and be better able to extrapolate to the summed effect of individual actions upon the environment.
>
> ....
>
> 5. become more interested in and look more closely at their environment, be willing to do something to try to improve their own environment...... (p.iv)

2.2 Selection of Experimental Teachers.

A modified Teaching Practices Questionnaire (Adams, 1970) and a Teacher Opinions Scale (A.S.E.P., 1973) were administered to a random sample of 42 science teachers, 78 science graduates undertaking the Diploma in Education at the University of Queensland. The data from

....

this administration were combined with that obtained from 66 teachers, 73 Dip. Ed. students and 16 A.S.E.P. staff in an earlier study (Tisher and Power, 1973). The combined data were analyzed using a principal components procedure followed by a varimax rotation. An eigen value cut-off of 1.0 was used. Factors were extracted in the analysis and varimax scores on these were obtained for all persons. The varimax scores were then used in a Hierarchial Grouping Analysis (H. Group) (Veldman, 1967) to establish clusters of individuals. Only the 42 science teachers and 78 Dip. Eds. plus the 16 A.S.E.P. staff were used in H. Group. A Multiple Discriminant Analysis was employed to determine the manner in which the clusters established by H. Group actually differed from each other. Each cluster contained teachers whose expressed values about teaching and about science curricula were similar.

In the clustering described above scores on eleven factors were used. These factors correspond closely with those extracted in the component analysis carried out with our 1972 data (Tisher and Power, 1973). A second clustering analysis was undertaken, but, in terms of simpler, more parsimonious scales than those based on the factors from the varimax procedure. From an examination of the information from the factor analysis we established three empirical-rational scales containing items which loaded highly on similar factors and rationally appeared to be measuring similar features. Further details appear throughout this report, and the Practices and Opinions Questionnaires are reproduced in Appendix B. At this stage it is appropriate to note the scales were named

1. Inquiry Orientation
2. Humanistic Values
3. Progressive Pedagogy

The first ($\alpha = 0.82$) included items which related to the teacher's beliefs concerning inquiry-oriented teaching, pupil experimentation, and free communication in class. The second ($\alpha = 0.74$) included those items which referred to the worth of individuals, personal and social development of pupils, and the social implications of scientific knowledge. The third scale ($\alpha = 0.87$) included those items dealing with classroom rules governing communication and behaviour and the teacher's role in managing lessons. When teachers, Dip. Eds. and A.S.E.P. staff were clustered using scores on these three preceding scales similar clusters were obtained to those established using factor scores. Experienced teachers (8) and Dip. Eds. (12) representative of each cluster were selected as the experimental teachers in the study. The experienced teachers remained with their usual grade 9 class (average size = 25) and the classes of the Dip. Eds. comprised 10 to 12 pupils drawn randomly from those classes they were assigned to during practice teaching. All Dip. Eds. had taught the classes in a previous practice period so they were known to their pupils.

....

2.3 Tests Administered to Pupils.

Attitude and achievement pre-tests were administered to all experimental classes before teaching on the unit began and post-tests were administered when pupils had completed the core of the A.S.E.P. unit. Details of these tests appear in the Appendix with the relevant test/item statistics. Modified forms of the Learning Environment Inventory (L.E.I.) (Anderson, 1971) and the Class Activities Questionnaire (C.A.Q.) (Steele, House and Kerins, 1971) were also administered as pre and post-tests. These two instruments were designed to measure pupils' perceptions of their learning environments and typify the two main approaches to the assessment of classroom learning environments. The approach in the L.E.I. is

> "based on the students' perceptions toward classroom environment which reflect the relationship of the students to the subject studied, to one another, to the organizational properties of the class and to the physical environment..."
>
> (Randhawa and Fu, 1973, p.316)

The approach in the C.A.Q., on the other hand, is based on pupils' observations of the general types of activities which characterize their class.

The modified form of the L.E.I. contained 90 statements which belong to 15 scales. In Table 2.1 each item is listed together with the name of the scale to which it is assigned, the alpha reliability of the scale, and the correlation of the item with its scale. Information derived from the L.E.I. manual (Anderson, 1971) is also provided for purposes of comparison.

The C.A.Q. contained 26 items designed to assess four major dimensions of instructional climate, namely lower thought processes, higher thought processes, classroom focus and classroom climate. Steele, House and Kerins (1971) grouped these items into sixteen logical factors (or scales) which were postulated to provide measures on the four dimensions. In an earlier study we followed the Steele, House and Kerins (1971) procedure to ascertain the degree to which empirical data supported the logical structure. We undertook a principal components analysis of the C.A.Q. items followed by a varimax rotation which produced eight components accounting for 52.6 per cent of the variance. These eight components comprise eight C.A.Q. scales used in this study. The names assigned to these scales, the per cent of variance accounted for by each one, and the items loading on each scale with their item number appear in Table 2.2. The last column in this table contains information from the Steele, House and Kerins Illinois analysis and gives the number of the Illinois factors on which the items loaded plus their varimax loadings.

....

TABLE 2.1

Learning Environment Inventory Scales, Items, and Reliabilities

Item No.	Scale	Alpha Reliability		Correlation of Item with Scale	
		This Study	Anderson (1971)	This Study	Anderson (1971)
	1. Cohesiveness	0.80	0.78		
1.	Members of the class do favours for one another.			0.66	0.42
13.	A student has the chance to get to know all other students in the class.			0.70	0.66
22.	Most students in the class are good friends.			0.73	0.55
32.	All students know each other very well.			0.71	0.78
R40.	The class is made up of individuals who do not know each other well.			0.72	0.76
54.	Each student knows the other members of the class by their first names.			0.72	0.73
	2. Diversity	0.78	0.58		
3.	Different students in the class are interested in different parts of the course.			0.74	0.53
23.	Some students are interested in completely different things than other students.			0.71	0.61
25.	Most students would rather work on something they like than for everyone to work on the one thing.			0.74	0.52
41.	In our class, some students want to learn about the subject, some only want to be popular, and some want out.			0.68	0.51
51.	Who works in class depends on which area of the subject we are doing.			0.60	0.54
56.	Different students vary a great deal regarding which part of the subject they are interested in.			0.68	0.57
	3. Formality.	0.59	0.76		
6.	Students who break the rules are punished.			0.62	0.50
12.	The class has rules that it must follow in the laboratory/or in field work.			0.67	0.67
28.	Students have to follow strict rules in this class.			0.56	-
R34.	The lessons are rather casual.			0.38	0.60
36.	There is a right and wrong way of doing things in the lessons.			0.58	0.48
47.	The class knows exactly what standard of behaviour is expected of them in the lessons.			0.60	0.69

	4. Speed	0.69	0.77		
18.	We always have to rush through our work in the subject.			0.68	0.70
R42.	The class has plenty of time to cover the work in the subject.			0.67	0.66
R44.	Students do not have to hurry to finish their work.			0.73	0.67
50.	There is little time for day-dreaming.			0.37	0.44
52.	The class members feel rushed to finish their work.			0.78	0.75
55.	The class has difficulty keeping up with its homework in this subject.			0.55	0.59
	5. Environment	0.61	0.65		
2.	The classroom is so well equipped that anything students need or want is available to them.			0.49	0.55
10.	A good collection of social science/science books and magazines is available in the school for students to use.			0.62	0.52
17.	The students would be proud to show the classroom to a visitor.			0.62	0.57
24.	The classroom is bright and comfortable.			0.71	0.61
31.	There are pictures, charts and displays around the room.			0.52	0.46
R33.	The classroom is too crowded.			0.54	0.48
	6. Friction	0.78	0.78		
7.	There is constant squabbling among class members.			0.56	0.57
20.	Certain members have no respect for other students.			0.69	0.69
27.	Some students annoy others so much in class that our work suffers.			0.73	0.70
39.	Certain students in the class are trouble-makers.			0.76	0.74
48.	Certain students don't like other students.			0.71	0.66
53.	Certain students are considered uncooperative.			0.70	0.65
	7. Goal Direction	0.76	0.86		
9.	The class knows exactly what it has to get done.			[illegible]	0.70
R16	Most students in the class don't know why they have to study the subject.			0.72	0.76
R35	Students have little idea of what the real point of studying the subject is.			0.57	0.78
38	Each student knows exactly what is expected of him in the lessons.			0.70	0.77
49	The class realizes exactly how much work it has to do.			0.70	0.70
57.	Each student in the class has a clear idea why the subject is important.			0.70	0.76

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	8. Favouritism	0.71	0.78		
8.	The teacher spends more time answering the questions of good students than those of poor students.			0.66	0.62
R11.	Every member of the class enjoys the same privileges.			0.54	0.66
15.	The good students can do things in the laboratory/ or on field-work that other students are not allowed to do.			0.57	0.71
29.	Teacher's pets have most say in what the class does.			0.73	0.66
43.	Students who have bad reputations are picked on in class.			0.58	0.57
59.	Certain students are teacher's pets.			0.73	0.75
	9. Cliqueness	0.70	0.74		
4.	Certain students work only with their close friends.			0.73	0.63
19.	Some students refuse to mix with the rest of the class.			0.57	0.60
21.	Some students can always work together no matter what the rest of the class is doing			0.57	0.65
45.	Certain groups of friends tend to sit together.			0.73	0.62
R58.	Most students try to help others whenever they can.			0.46	0.53
60.	Certain students stick together.			0.74	0.70
	10. Satisfaction	0.81	0.80		
5.	The students enjoy their class work.			0.74	0.66
R14.	Many students dislike the work done in lessons.			0.72	0.67
R26.	Students in our class don't really enjoy the work we have to do in the subject.			0.69	0.68
30.	The class really looks forward to coming to lessons.			0.63	0.68
37.	After the class, the students feel the lessons were worthwhile.			0.76	0.75
46.	Students really enjoy the lessons.			0.77	0.77
	11. Disorganization	0.82	0.82		
1.	There are long periods during which the class does nothing.			0.77	0.65
4.	The work of the class is frequently interrupted when some students have nothing to do.			0.60	0.58
R7.	The class is well organised.			0.73	0.80
10.	The class is a shambles.			0.77	0.80
R13.	The lessons run smoothly.			0.76	0.74
27.	There is a great deal of confusion during the lessons.			0.73	0.68

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	*12. Difficulty	0.67	0.66		
2.	The lessons are hard.			0.62	0.67
14.	Students are always being asked tough questions in the lessons.			0.48	0.55
R17.	The subject requires no particular ability on the part of the students.			0.54	0.58
21.	Students in the class tend to find the subject hard to do.			0.73	0.63
R23.	The lessons are too easy for many students.			0.62	0.56
R29	Most students consider the subject easy.			0.68	0.60
	*13. Apathy.	0.75	0.83		
9.	If the class did badly in the subject exam, most students couldn't care less.			0.72	0.67
15.	Students don't care about the future of the class as a whole.			0.71	0.74
18.	Some students couldn't care less what the rest of the class does in the lessons.			0.58	0.64
R25.	Most students sincerely want the class to be a success.			0.63	0.71
26.	Failure in exams would mean nothing to most members of the class.			0.58	0.74
R28.	Students want the class to make real progress in the subject.			[illegible]	0.72
	*14. Democratic	0.53	0.67		
5.	Class decisions tend to be made by all the students.			0.59	0.62
6.	Students have a say in what work the class does.			0.56	0.53
R8.	Certain students are more bossy in class than others.			0.45	0.57
16.	Each member of the class has as much say as any other member.			0.58	0.66
19.	What the class does is determined by the students.			0.62	0.56
R24.	A few members of the class have much greater influence than the other members.			0.46	0.63
	*15. Competitiveness	0.72	0.78		
3.	Most students want their work to be better than their friends' work.			0.72	0.67
11.	Students compete to see who can do the best work.			0.72	0.79
13.	A few of the class members always try to do better than the others.			0.68	0.55
R20.	Most students try to help one another.			0.33	0.56
22.	There is much competition in the class.			0.69	0.71
R30.	Students seldom compete with one another.			0.74	0.74

* **Note** Items associated with these scales appeared on a second form of the questionnaire.

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TABLE 2.2

COMPONENT ANALYSIS OF THE CLASS ACTIVITIES QUESTIONNAIRE

Component & percent of variance	Item numbers, key words and varimax loadings.	Factor Number & Loading (Illinois data)
I. Independent Inquiry (10.4)	44. Independently explore (.69)	I (.57)
	47. Discover many solutions (.65)	(not reported)
	53. Invent, design, compose (.63)	I (.71)
	48. Ideas more important than grades (.61)	(excluded)
	43. Practice skills in problem solving (.50)	I (.45)
	49. Excited and involved in class (.48)	IV (-.65)
II. Indifference (5.8)	54. Do not enjoy ideas studied (.72)	(excluded)
	45. Little opportunity for participation (.59)	IV (.69)
III. Humour (5.4)	55. Little joking or laughing (.72)	VI (.96)
	32. Make judgments of good/bad (-.46)	IX (.83)
IV. Cramming (7.7)	52. Great concern for grades (.68)	II (.64)
	40. Emphasis on memorizing (.62)	II (.73)
	65. (Amount of)Teacher Talk (.63)	(excluded)
	42. Thinking through complicated problems (.42)	V (.72)
	34. Do other things than listening (-.40)	VIII (.93)
V. Interpretation (6.5)	36. Go beyond information given (.74)	III (0.71)
	46. Find trends and consequences (.61)	III (-.80)
	41. Build to produce something new (.42)	I (.64)
VI.Participation (5.5)	35. Actively participate in discussion (.69)	IV (-.78)
	45. Little opportunity for discussion (-.33)	IV (.69)
VII.Translation (7.1)	39. Restate ideas (.60)	VII (-.80)
	51. Explaining and summarizing (.65)	VII (-.45)
	38. Know the one best answer (.44)	II (.64)
	50. Judge the value of ideas (.45)	X (.69)
VIII. Information Processing (6.3)	33. Put methods and ideas to use (.65)	I (.56)
	31. Remember information(.61)	II (.53)
	37. Logical reasoning and analysis (.52)	V (.73)

Note: Three additional scales (3 items each) were used to assess the extent to which pupils perceived that they were involved in class, initiated activities, and had a teacher who was concerned about them.

2.4 Experimental Treatments.

Data were obtained from 20 classes containing 326 pupils, of which 131 were in the classes of the 12 Dip. Eds.

The classes of the 12 diploma students were allocated to four different treatments so that a Dip. Ed. from each of the three value clusters was assigned to one of the treatments. The treatments were as follows:-

Treatment 1: A.S.E.P. Materials

The classes in this treatment used the A.S.E.P. pupils' guide, record book and ancillary materials. Pupils' activities were guided by the instruction in the curriculum materials and the teacher's role was essentially that of a resource person.

Treatment 2: Pre-Structuring

The classes in this treatment used the A.S.E.P. materials as specified in Treatment 1. However, this treatment differed from Treatment 1 in the first lesson where the teacher (a) provided an overview of the basic ideas to be covered in the unit, and (b) screened the B.S.C.S. film "Population Ecology" which acted as an advance organizer for the work in the unit.

Treatment 3: Mid-Structuring

This treatment was similar to Treatment 2 except for the timing of the structuring. The film was shown half-way through the core and there was a review of the ideas covered to date and an overview of those still to come.

Treatment 4: Post-Structuring.

In this treatment, which was similar to Treatment 2, the film screening and review occurred in the last lesson on the core of the A.S.E.P. unit.

All diplomates undertook a training course designed to assist them when they used the A.S.E.P. unit "How Many People". Those diplomates who were assigned to Treatments 2, 3 and 4 received additional training to help them with the structuring activities.

The eight experienced teachers were also trained to use the A.S.E.P. materials, but were not assigned to treatments as were the Dip. Eds. All experienced teachers screened the B.S.C.S. film when their classes commenced work on "How Many People".

2.5 Sampling of Classroom Behaviours.

In a previous study (Tisher and Power, 1973) a scheme was developed for analysing behaviour in A.S.E.P. classrooms. This scheme, SABIC, is described in greater detail in Appendix A. In this study SABIC was used to categorize the variety of activities occurring in the self-paced lessons. However, an observer is faced with what has been called the "cocktail party problem" on who, what and for how long does one focus in a room buzzing with activity? We "solved" the problem as follows:

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A video-record was obtained of the A.S.E.P. lessons using two video-cameras, three microphones and a control console incorporating audio and video-mixers. Of the three microphones, one, a radio micro-phone, was placed on the teacher, the other two were located on tables in front of two groups of pupils. During a recording session cameras followed a pupil group or the teacher for three minute intervals. In that period only the relevant microphones were turned up. At the beginning of a lesson the teacher was recorded first, then a group of pupils, a second group of pupils, back to the teacher, a third group of pupils, a fourth group, back to the teacher, and so on. While the video-recorder was operating an electronic beep was fed into the audio-track at 10 second intervals. The beep was designed to act as a marker during analysis of the video-recordings.

The basic unit of analysis in SABIC was the dominant behaviour observed during each of the ten second intervals. A time rather than a functional unit was selected because sampling the teachers' and groups' behaviours for three minute intervals precluded the possibility of a continuous behavioural record. However, we do recognize the need for other studies in which functional units are used and where sequences of behaviours can be examined. In this project it was not possible to obtain a valid sample of the lesson activities and lengthy sequences of activities for all pupils. We concentrated on sampling from the smorgasbord of lesson activities.

A total of 40 lessons were recorded and analysed using SABIC (i.e. in each class, two of the lessons required to complete the core material). The results of these analyses are given in subsequent sections of this report.

3. THE NATURE OF THE LEARNING ENVIRONMENT
(Ecological Data)

3.1 Classes of Knowledge about the teaching process.

Several writers, including Dunkin and Biddle (1974) maintain that there are several classes of knowledge about the teaching process; viz. -

- knowledge associated with the conceptualisation of the process,
- knowledge about the nature of the learning environment, and
- knowledge about relationships between
  a) presage and process variables
  b) process and product variables
  c) contextual and process variables,
  and d) relationships among processes.

This report is intended to contribute to our understanding of the teaching-learning process and the discussions have been grouped to take account of the several classes of knowledge referred to above. For example, Chapter 1 of the report contained a description of the paradigm which has guided the research and indicates our conceptualisation of the teaching process in classrooms where self-paced learning materials are used. In this chapter the nature of the learning environments is described in some detail by presenting selections of the ecological data which were collected during the study. The information is intended to provide "a background canvas" for subsequent discussions on the relationships which were found to occur between a number of variables.

The ecological data has been grouped and relates, respectively, to presage, process, product and contextual variables. The data on presage variables deals with the nature of the experimental teachers' beliefs (values) about the teaching-learning process. This first section also contains a description of how the experimental value clusters were derived. The second section of the chapter deals with the classes of the experienced teachers and the diplomates. Then there is a brief account of the results from some of the criterion tests including post-achievement scores and gains in affective and cognitive measures. There follows a description of pupils' perceptions of their learning environments - information derived from the administration of the Learning Environment Inventory and Class Activities Questionnaire - plus a smorgasbord of anecdotal information which was obtained from their replies to an open response question on the post-criterion test paper.

3.2 Nature of Teacher Values.

The teacher is one of the main sources of curriculum stability in schools, a fact, which though generally recognised, has only recently been considered seriously by curriculum innovators and implementors. An examination of the nature of educational systems gives support to ....

the notion. The control activities of teaching, for example, have been visible to persons who are now teachers for a considerable length of their lives, including their early school years. The ideas formed through numerous significant contacts are hard to unlearn and it is difficult to depart from practices hallowed by tradition. Yet changes and departures do occur, and teachers do accommodate to different curriculum materials - or so it seems. To what extent teachers do (a) depart from hallowed traditional practices when new curriculum materials are introduced, and (b) modify the curriculum's teaching procedures to accord with their own beliefs about teaching, are important issues. In this project we have gathered information associated with the second one by asking teachers to respond to questionnaires and by observing their classrooms.

To gain information about teachers' educational beliefs, a teaching practices and an opinions scales were administered to a representative sample of 42 grade 9 science teachers, 16 members of the A.S.E.P. staff and 78 science graduates in a diploma in education programme. The teaching practices questionnaire was a modified version of one used in an international study on teachers' roles. It is reproduced in the appendix. The complete instrument contains 30 items dealing with the emphasis teachers give to various classroom practices. The opinions scale contains items which refer to the educational beliefs that influence the nature of science courses for pupils in grades 7 to 10. The beliefs were those which appeared to have guided the A.S.E.P. curriculum developers.

3.21 Components Analysis

A variety of procedures have been proposed for the classification of individuals into groups - or clusters. In this study the Hierarchical Grouping (H. Group) Analysis procedure was used but it was preceded by several important steps. First, a principal components analysis, followed by a varimax rotation was undertaken on the data obtained from the administration of the teaching practices and opinions scales. An eigen value cut-off of 1.0 was used and 60.35 per cent of the trace was extracted by 14 factors, the first eleven of which were categorized and named as follows: (note: the number on the left hand side refers to the original item number in the questionnaire, the number in parenthesis on the right is the varimax loading of the item and the statement contains the key words in the original item).

Factor 1 (8.79 variance) Social and Personal Development

4.	course should contribute to personal and social development	(0.71)
7.	course should emphasize social implications	(0.72)
15.	understanding of social and interpersonal relations	(0.72)
16.	development of personal attributes .. can be fostered by a science curriculum	(0.67)

...

17.	knowledge of everyday life should have preference	(0.60)
13.	findings of behavioural sciences should form part of science curriculum	(0.56)
Factor 2	(8.8% variance) Convergent Activity	
2.3	Emphasis on free communication	(-0.68)
3.3	Emphasis on different activities for different groups	(-0.72)
4.2	Emphasis on rules established by agreement	(-0.63)
4.3	Emphasis on rules established by pupils themselves	(-0.73)
7.3	Emphasis on problem centred approach	(-0.72)
8.3	Emphasis on pupils devising own experiments	(-0.78)
9.3	Emphasis on first hand experiences	(-0.62)
3.1	Emphasis on same activity for whole class.	(0.40)
Factor 3	(4.2% variance) Emphasis on rules and discipline	
1.3	Emphasis on disciplining and controlling	(0.54)
4.1	Emphasis on rules established by teacher	(0.69)
5.1	Emphasis on rules how pupils must behave	(0.78)
6.3	Emphasis on effective use of punishment	(0.40)
Factor 4	(2.6% variance) Professionalism	
20	Need for in-service education	(0.63)
8.2	Need for structured worksheets	(-0.54)
Factor 5	(5.1% variance) Emphasis on Conceptual Schemes	
1.	All students should have knowledge of a fundamental core of scientific knowledge	(0.69)
2.	Course should reflect structure of the scientific disciplines.	(0.70)
14.	Science course should deal with main scientific theories.	(0.58)
21.	A.S.E.P. should be separated into major branches of science.	(0.58)
22.	Pupils should have printed copies of material to be learnt.	(0.56)
Factor 6	(7.4% variance) Curriculum Dependency	
10.	Science course should include some knowledge about historical developments of science.	(-0.48)
19.	A.S.E.P. materials should be 'teacher-proof'	(0.69)

...

Factor 7 (2.9% variance) **Intrinsic Motivation**

6.1	Emphasis on effective use of rewards	(-0.78)
6.2	Emphasis on intrinsic motivation	(0.74)

Factor 8 (4.4% variance) **Teacher Centred Approach (R)**

2.2	Emphasis on question-answer techniques.	(-0.57)
3.1	Emphasis on same activity for class	(-0.54)
8.1	Emphasis on teacher demonstrations	(-0.68)
9.1	Emphasis on teacher as source of information	(-0.68)
10.1	Emphasis on re-inforcing answers as 'right' or 'wrong'.	(-0.44)

Factor 9 (2.6% variance) **Depth Orientation**

7.1	Emphasis on broad survey of science	(-0.74)
7.2	Emphasis on a few topics in depth	(0.49)

Factor 10 (4.1% variance) **Behaviour Orientation**

23	Science should include open-ended investigations	(-0.52)
10.1	Emphasis on re-inforcing answers as 'right' or 'wrong'	(0.51)
10.2	Encouraging pupils to decide if answer is correct.	(-0.56)
10.3	Emphasis on probing pupils' answers	(-0.46)

Factor 11 (6.5% variance) **Small Group Investigation**

3.	Science course should develop attitudes of commitment to enquiry, open-mindedness	(0.49)
5.	Course should be based on student observation and experiment.	(0.61)
6.	Course should be based on processes of science	(0.46)
11.	Class work should be done in small groups	(0.54)
25.	Practical experiences in science will have a lasting impact on pupils.	(0.53)
26.	Teacher is better employed in giving lectures and demonstrations.	(-0.65)
27.	Pupils gain little from conducting their own experiments.	(-0.72)

The preceding factors correspond to those which were extracted in a previous study (Fisher and Power, 1973). The preceding factors were used in a number of the analyses which are reported in subsequent chapters. But, in addition, they were used to establish three more parsimonious scales to measure the value orientations of teachers. Whereas the extracted factors provided the major (empirical) evidence for the construction of the three "simple" scales, some items which did not appear to belong logically to a scale were placed in a more appropriate group. Note, that the reclassification was a rationale process.

....

The three scales were named:-

I. Inquiry Orientation
II. Humanistic Values
III. Progressive Pedagogy

As indicated in Chapter 2, the first included items which related to the teacher's belief about inquiry-oriented teaching, pupil experimentation and free communication in classes. The second included those which referred to the worth of individuals, social development and the social implications of scientific knowledge. Finally, the third scale included items dealing with classroom rules governing behaviour and the teacher's role in managing lessons. Table 3.1 contains a list of the item numbers, the scale to which the items were assigned, the point biserial correlation of the item with its scale score and the alpha values for each of the three parsimonious scales.

TABLE 3.1

Item Statistics for the Practices and opinions scales

Item Number	Assigned to Scale	Point Biserial Correlation with Scale Score
1	II	0.31
2	II	0.41
3	I	0.49
4	II	0.58
5	I	0.54
6	I	0.52
7	II	0.60
8	II	0.57
9	I	0.58
10	II	0.20
11	I	0.53
12	II	0.52
13	II	0.63
14	II	0.22
15	II	0.68
16	II	0.53
17	II	0.43
18	II	0.44
19	III	0.24
20	III	0.13
21	II	0.55
22	II	0.41
23	I	0.51
24	I	0.33
25	I	0.51

...

Item Number	Assigned to Scale	Point Biserial Correlation with Scale Score.
26	I	0.50
27	I	0.51
1.1	I	0.12
1.2	I	0.53
1.3	III	0.51
2.1	III	0.44
2.2	III	0.23
2.3	I	0.61
3.1	III	0.56
3.2	III	0.08
3.3	I	0.45
4.1	III	0.63
4.2	III	0.40
4.3	III	0.41
5.1	III	0.54
5.2	III	0.20
5.3	III	0.32
6.1	III	0.29
6.2	III	0.46
6.3	III	0.40
7.1	II	0.18
7.2	II	0.29
7.3	I	0.49
8.1	III	0.49
8.2	III	0.02
8.3	I	0.51
9.1	III	0.47
9.2	III	0.32
9.3	I	0.59
10.1	III	0.49
10.2	I	0.45
10.3	I	0.52

Alpha Values

Scale I = 0.82
Scale II = 0.74
Scale III = 0.87

3.2 Value Clusters

The H Group procedure is one which begins by defining each of the original N persons to be clustered as a 'group'. These N groups are then reduced by a series of step decisions until all N persons have been classified into one or the other of two groups. The computer programme H Group is designed to deal with the problem of profile similarity and utilises the total within- ....

groups variance to be minimally increased at each step in the process. When there is a dramatic increase in the total within-groups variance, dissimilar groups have been combined.

A number of important considerations must be taken into account in using H Group. It must be noted that each variable is equally important in determining the single index between pairs of groups and that variables with smaller variances contribute less to the index of group distance than those with larger variances. The use of varimax factor scores means variation does not arise. In this study both varimax scores and the three scale values described previously were used. Similar clusters were obtained in each case. When the three scale values were employed scale scores on the raw data matrix were pre-standardised before computation of the initial error matrix. The increases in error with successive combinations in H Group were as follows:

No. of groups	Error term
135	0.01
100	0.05
50	0.37
10	5.75
6	15.46
5	16.12
4	24.45
3	28.90
2	64.28

As a large error increase occurred when the number of groups was reduced from three to two it seemed reasonable to assume that the teachers, Dip. Eds. and A.S.E.P. staff cluster into three basic groups, the membership of which was as follows:

TABLE 3.2

Discriminant Analysis Data for Teachers,
Diplomates and A.S.E.P. Staff:
Grouping on the Basis of Scale Scores

Section A:

		Significance levels
Wilks Lamba	= 0.17	$F_{(6,262)}$ = 61.5*
Root 1	=87.8% variance	$^{2}_{(4)}$ = 18[illegible]7*
Root 2	=12.2% variance	$^{2}_{(2)}$ = 47.15*

* p 0.0001

Section B

	Group Centroids Function 1	Function 2
Group I	-2.34	-1.13
Group II	-0.46	0.50
Group III	2.87	0.46

...

TABLE 3.2 (Cont.)

Section C

Correlations between Discriminant Functions and the Scales derived from Practices and Opinions Questionnaires.

Scale Name	Function 1	Function 2
I. Inquiry Orientation	0.93	-0.32
II. Humanistic Values	0.86	0.24
III. Progressive Pedagogy	0.64	0.59

Group I. (N = 33)
with 22 teachers, 9 diplomates and 2 A.S.E.P. staff
Group II (N = 82)
with 19 teachers, 59 diplomates and 4 A.S.E.P. staff, and
Group III (N = 21)
with 1 teacher, 10 diplomates, and 10 A.S.E.P. staff.

Using the pre-standardised scale scores a multiple discriminant analysis was completed to determine the nature of the difference among the three groups and the results of this analysis are summarised in Table 3.2. The three groups, or clusters, can be described in terms of the two discriminant functions and our description of these is as follows:

Group I (Dissonant)

These persons believe that the teacher should be the dominant actor in class, controlling, disciplining, demonstrating and providing all the necessary scientific information. They also believe that the whole class should work on an activity (but not in groups), pupils should not devise and conduct their own experiments.

Group II (Mixed Mode)

These persons have some beliefs similar to those in Group I and some beliefs similar to those in Group III. For example, they value adequate communication between members of a class, supportive personal relationships between teacher and pupils and a broad coverage of scientific subject matter. Also, they believe the teacher should be the dominant actor in class, controlling, disciplining, demonstrating and providing all the necessary scientific information. They do believe there should be rules to guide pupils' behaviour but they appear to be in a 'mixed-mode' with respect to whether pupils should have a first-hand experience with phenomena and should devise their own experiments in groups.

Group III. (Congruent)

> Persons who value adequate communication between members of a class, supportive personal relationships between teacher and pupils, and broad coverage of scientific subject matter (i.e. wide ranging courses). They do not believe the teacher should be the dominant actor in class, controlling, disciplining, demonstrating and providing all the necessary scientific information. On the contrary, they believe that pupils should have a first hand experience with phenomena, and should devise and conduct their own experiments in groups. Also, they do believe that there should be rules to guide pupils' behaviour.

Twenty experimental teachers (12 diplomates and 8 grade 9 science teachers) were selected from the three H Group clusters on the basis of their proximity to the centroid of their particular cluster. Note, only one teacher was grouped into cluster III and this person was not located close to the group centroid. Table 3.3 contains a listing of the identification numbers assigned to the experimental teachers and their scores on each of the three empirical-rational values scales.

Note, that in the clustering two A.S.E.P. staff were classified into Group I which was named the Dissonant Group, i.e. the group whose educational values did not conform with those of the A.S.E.P. curriculum materials. Also, four of the A.S.E.P. staff were clustered into Group II whose educational values were in a 'mixed mode', i.e. there was some attachment to a progressive teaching ideology and to the notion of a teacher-centred classroom. The majority of grade 9 science teachers also belonged to these two groups, whereas a proportion of Dip. Eds. belonged to Group III whose educational values were congruent to those expressed in the A.S.E.P. curriculum materials.

3.3 Activities in the Experimental Classes

Using SABIC, the classificatory scheme developed for this and the preceding study, it was possible to extract a great deal of information about the activities in the experimental classes. In this section we report on the nature of these activities. In subsequent chapters there is a discussion on the associations between the various behaviour categories and the process and product variables. Some writers (e.g. Nuthall and Church, 1972) suggest that the validity of a particular category is to be assessed by the extent to which it ...

SCALE I - INQUIRY ORIENTATION
SCALE II - HUMANISTIC VALUES
SCALE III - PROGRESSIVE PEDAGOGY

TABLE 3.3

Value Scores for the Experimental Teachers

	Value Clusters											
	DISSONANT GROUP				MIXED MODE GROUP				CONGRUENT GROUP			
	TEACHER NO.	SCALE I.	SCALE II.	SCALE III.	TEACHER NO.	SCALE I.	SCALE II.	SCALE III.	TEACHER NO.	SCALE I.	SCALE II.	SCALE III.
EXPERIENCED TEACHERS	TV048	47	36	63	TV025	73	53	62				
	TV051	52	41	60	TV027	71	56	71				
	TV052	47	32	44	TV026	78	63	70				
	TV046	56	49	61	TV047	80	59	47				
DIP. ED. TRAINEES	DV072	64	52	72	DV019	77	56	66	DV057	78	75	72
	DV052	60	55	67	DV042	72	52	64	DV040	83	74	74
	DV048	58	53	71	DV005	68	64	68	DV014	75	72	70
	DV027	56	57	53	DV024	72	61	74	DV054	83	69	76

correlates with specified outcomes. However, the usefulness of a scheme must also be judged in terms of the description it provides of the nature of the activities in lessons, and whether it allows distinctions to be made between different types of lessons.

3.31 Activities in the experienced teachers' classes.

Table 3.4 contains the results of the analysis of the video-tapes for the classes taught by the experienced teachers. The frequency of each category is expressed as a percentage of the set of categories to which it belonged. For example, the table indicates that in the classes of the teachers with 'mixed mode' values pupils were the sources of activities on 16.9% of the occasions when sources were identified. Teachers were the sources of activities on 44.2% of occasions. In contrast, in the classes of the dissonant teachers pupils were the sources of activities on 25.0% of occasions and teachers on 26.6% This was somewhat unexpected for we had anticipated that the Group I teachers would have dominated activities to a greater extent than the Group II teachers.

Other expectations were fulfilled. For example, in the classes of the dissonant (Group I) teachers there were greater proportions of direction giving, fact-stating, outlining of purposes and checking on progress than in the classes of the mixed mode (Group II) teachers. Yet, it is intriguing to note that there were greater proportions of information giving, teacher-class interactions and question and answer in the mixed mode classes than in the dissonant ones.

In all classes writing, experimenting, observing, reading and 'resting' (no activity) occurred on a substantial number of occasions ranging from 31.6% for the Group II (mixed mode) classes to 46.7% of occasions for the Group I classes. It is to be expected that in self-paced classes a considerable proportion of time will be taken in these activities, but in this study it was the pupils in the Group I classes who devoted a greater proportion of their activities to these, and especially to writing and observing.

There were displays of affect in classes of both groups I and II, but generally this was only a small proportion of all the functions classified. This finding may be taken to indicate that the classes were neutral (or emotional deserts, as some writers have said), but we prefer to be more cautious. Certainly the teachers did not praise or criticise pupils excessively, but this does not necessarily mean pupils were dissatisfied or not motivated since the nature of the self-paced learning environment may have provided intrinsic satisfactions.

3.32 Activities in the classes of the diplomates.

Table 3.5 contains the results of the analysis of the video-tapes for the classes taught by the Diploma in Education students. Comparisons among these classes and between the classes of the experienced teachers are extremely difficult because of the great variability in the nature of the activities in the groups listed in Table 3.5

TABLE 3.4

BASIC FREQUENCIES

In the experienced teachers' classes
(expressed in percentages)

Observational Category	Value Group I (Dissonant)	Value Group II (Mixed Mode)
Source Activity		
Pupil (P)	250	169
Group (G)	292	317
Teacher (T)	266	442
Target of Activity		
Pupil (P)	110	117
Group (G)	255	199
Class (C)	110	271
Teacher (T)	73	123
Material (M)	182	247
No target	64	45
Interactions		
P - M	133	198
P - T	56	101
P - P	178	165
T - M	113	21
T - C	97	266
T - P	151	153
Activities		
No activity	91	82
Questioning (Q)	60	126
Follow-up Question (Q')	8	33
Information Giving (I)	180	266
Direction Giving (D)	235	130
Writing (W)	160	54
Experimenting (E)	74	88
Observing (obs)	102	43
Reading (R)	40	49
Q-Answer	101	123
Functions		
Fact-stating (FAC)	126	105
Describing (DES)	28	46
Interpreting (INT)	72	22
Explaining (XPL)	83	152
Purposes (PUR)	113	3
Procedures (PRO)	165	198
Difficulties (DIF)	17	4
Progress (PRG)	147	5
Task Irrelevant (NTH)	109	44
Positive Affect (+)	62	6
Negative Affect (-)	5	1

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TABLE 3.5

SABIC FREQUENCIES
in the classes of the diplomates
(expressed as percentages)

Observational Category / Values Group	Structured			Pre-Structured			Post-Structured			Mid-Structured		
	I	II	III	I	II	III	I	II	III	I	II	III
Source of Activity												
Pupil (P)	168	168	172	55	259	354	191	190	203	219	185	230
Group (G)	433	389	348	372	285	416	411	433	359	455	408	273
Teacher (T)	398	442	128	500	455	214	397	364	432	320	375	464
Target of Activity												
Pupil (P)	178	373	135	82	160	48	183	185	155	157	216	136
Group (G)	389	396	281	96	351	637	375	395	475	381	329	329
Class (C)	26	13	38	238	49	62	4	52	165	14	65	115
Teacher (T)	172	97	187	87	146	57	207	136	115	162	91	169
Material (M)	234	129	125	440	284	195	225	218	87	279	225	250
No target	0	0	0	55	9	0	5	11	6	5	68	0
Interactions												
P - M	234	119	120	298	269	171	225	2k3	81	274	221	205
P - T	168	97	157	69	146	57	20	133	115	162	91	169
P - P	199	224	227	27	120	543	165	274	365	237	234	123
T - M	0	0	86	37	14	9	0	6	6	5	4	13
T - C	26	13	8	238	49	62	4	52	165	14	65	108
T - P	367	332	120	151	391	143	348	306	260	300	300	342
Activities												
No Activity	9	82	41	92	61	10	12	22	5	33	77	62
Questioning (Q)	184	189	58	119	177	81	120	180	168	200	220	219
Follow-up Question (Q')	0	18	9	23	0	15	7	16	5	14	0	29
Information Giving (I)	248	342	178	92	289	569	510	258	338	291	177	288
Direction Giving (D)	53	56	317	142	127	90	37	16	179	24	111	19
Writing (W)	22	0	125	96	117	33	60	16	32	159	63	39
Experimenting (E)	34	67	73	87	0	33	59	87	0	4	84	49
Observing (Obs)	110	5	155	137	44	28	23	139	26	48	35	94
Reading (R)	0	18	16	115	147	28	17	16	46	100	35	72
Q-Answer	341	227	347	96	35	109	151	247	198	175	248	127
Functions												
Fact-stating (FAC)	18	50	181	82	102	226	4	16	100	125	31	88
Describing (DES)	0	9	5	32	49	153	11	0	86	53	6	53
Interpreting (INT)	5	28	185	0	17	68	32	22	9	19	20	22
Explaining (XPL)	271	326	214	27	23	73	495	281	139	257	178	161
Purposes (PUR)	0	0	108	0	0	0	0	0	0	0	0	0
Procedures (PRO)	180	173	37	211	330	140	90	135	304	116	230	182
Difficulties (DIF)	0	5	8	0	14	0	32	11	26	10	25	0
Progress (PRG)	9	0	73	5	36	5	9	0	11	5	21	13
Task Irrelevant (NTH)	9	82	46	32	26	10	4	11	0	18	40	46
Positive Affect (+)	0	0	108	0	0	28	0	6	0	0	6	0
Negative Affect (-)	0	5	13	5	0	0	0	0	0	0	0	0

However, a number of comparisons can be made, but whether the differences are due to the nature of the ASEP materials, the experimental treatments or the relative inexperience of the diplomates is open to debate.

When the results in Table 3.5 are compared with those in Table 3.4 some differences are readily detected. For example, though direction giving occurs in the diplomates' classes, it is, overall, less frequent than in the experimental teachers' classes. Also, the discussion of purposes, or checking on progress occurs infrequently in the diplomates' classes, that is, less frequently than in the classes of the Group I experienced teachers. Generally, questioning occurs more frequently in the diplomates' classes than in those of the experienced teachers, but follow-up questions were rare in all classes. This is no doubt due to the nature of a self-paced learning environment where pupils who are working through materials or an experiment tend to ask those questions which give answers to help them in their task. Generally, follow-up questions, in these cases, are not necessary.

Explaining was a much more prevalent function in the diplomates' classes than in the experienced teachers' classes. Also, discussion of procedures to be followed appeared to occur more frequently in pre-structured Dip. Ed. classes than in the experienced teachers' classes.

It is appropriate to note that in all classes experimenting was an infrequent activity. This was due, no doubt, to the nature of the ASEP unit used in the classes. "How Many People" does not contain many experiments at all and most of the activities involve pupils in discussion, reading and writing. Given this state of affairs, it is nevertheless intriguing to note that writing was still a relatively infrequent activity in all classes.

There were displays of positive and negative affect in the diplomates' classes, but, as with the teachers, praise and criticism were by no means excessive. Task irrelevant functions were also low, as they were in the teachers' classes.

Parenthetically, it should be noted that there were a great number of variations among the classes of the diplomates; probably as many, if not more than occurred between their classes and those of the teachers.

3.4 Pupil Outcomes.

In the next chapter we report on some of the associations between class and individual outcomes and environmental variables and classroom behaviours. In this section we present some of the outcome measures for the classes for interest only. Table 3.6 contains class measures on post-achievement tests, and raw gains in achievement, in the environment attitudes and attitude to science lessons. Note that an analysis of variance between the groups using each of the variables in Table 3.6 only yielded one significant result (0.05 level) for the post achievement scores between the dissonant teacher group and the dissonant Dip. Ed. group.

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TABLE 3.6

CRITERION TESTS: POST ACHIEVEMENT: RAW GAINS

	DISSONANT GROUP					MIXED MODE GROUP					CONGRUENT GROUP				
	Post Achievement		Raw gains			Post Achievement		Raw Gains			Post Achievement		Raw Gains		
				Attitude					Attitude					Attitude	
	$\bar{x}$	S.D	Achievement	Envt.	Science	$\bar{x}$	S.D.	Achievement	Envt.	Science	$\bar{x}$	S.D.	Achievement	Envt.	Science
TEACHERS	18.19 15.25 12.18 11.29	4.23 2.79 3.76 3.19	3.49 3.66 1.65 0.48	9.99 6.04 6.47 1.22	42.14 48.33 42.64 32.86	17.26 15.77 10.67 17.55	3.70 3.38 2.61 2.50	4.00 3.49 4.30 3.00	6.18 1.82 -1.00 3.47	40.20 35.59 32.80 46.20					
DIP.EDS.	19.09 19.22 18.98 17.64	2.39 2.72 2.02 3.13	5.24 3.12 3.46 3.96	3.51 -4.35 12.00 9.23	37.46 43.76 39.08 27.99	18.50 18.50 19.10 18.50	2.53 1.36 2.70 1.80	3.76 2.50 3.40 3.60	-4.31 -0.69 6.70 3.90	33.59 31.40 50.90 54.20	16.83 18.60 18.40 17.11	3.16 2.65 2.20 1.85	1.58 4.90 3.80 2.21	-4.12 5.64 2.30 7.89	37.40 53.24 45.80 51.57

3.5 Criterion Tests: Pupils' Open-Ended Responses.

One of the purposes in the study was to obtain information on pupils' perceptions of their learning environments. This was achieved, in part, by administering the Learning Environment Inventory (LEI) and Class Activities Questionnaire (CAQ) during pre and post-testing phases. An attempt was also made to obtain more open-ended responses from pupils. The criterion achievement tests contained one question which asked pupils to indicate what, if anything, impressed them about their science lessons and to state what significant things they had learnt. The responses which were obtained at pre and post-testing were studied to determine whether there were any prevalent recurring themes and whether there were any marked differences in patterns of responses between the various groups e.g. dissonant and mixed modes. No marked differences were obvious between the groups, in fact, there were as many differences and variations between the groups as there were within the classes. Certainly the patterns of responses were very variable, but it was possible to detect some recurring features.

Among the pre-test responses there were a number (approximately one to two per cent) who commented that they had enjoyed science much more in primary school than in the secondary school. For them science was now dull and boring and contained a high percentage of useless information. Fortunately most of these pupils found that the ASEP unit was "fun to do".

At the pre-test stage over 50 per cent of all the pupils singled out one or more topics in biology as the best and most useful ones they had studied. Chemistry topics were the next most frequently mentioned. We gained the impression that the biology and chemistry strands of the standard junior science course were the most appreciated by the pupils in both the dissonant and mixed mode groups. Topics in physics and astronomy were also mentioned by the pupils, but there was quite a contrast to the frequency with which biology and chemistry were mentioned. Physics topics were recorded by about only one third of all the pupils. The pattern of responses and range of topics mentioned was somewhat similar for the dissonant and mixed mode classes.

At post-testing a variety of responses was obtained once more from all classes and there was no marked difference between the various groups. However, on this occasion the topics were derived from those covered in the ASEP unit. The majority of pupils commented that they had learnt a great deal about the dangers associated with pollution and over-population. Two of the more well-expressed statements were:

- "People should be made to pay heavy fines and penalties for helping pollute their environment."
- "I think too much money is wasted on minor problems rather than problems such as controlling births, recycling goods, controlling pollution rate, because if man does not do anything soon they won't be able to do anything at all."

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The importance and value of graphs, taking a census, and world's resources, were also included in the list of significant things in the ASEP unit. However, only a few pupils, of the order of 25 per cent at the most, expressed any delight in the change of teaching style from the more conventional teacher dominated type to group activities within classes. This may be due, in part, to the fact that their teachers did still control and guide classroom activities, although less time was spent on public discussion of the cognitive content of the unit. It was the case that several pupils commented on the 'new' teaching style. Some said they were pleased to have had the opportunity to work in small groups, others appreciated the freedom to work independently, one enjoyed the opportunity to "muck around" and he admitted he did learn more "in his other (science) lessons". Another said:

- "I learnt that my science classes could be interesting and enjoyable, but that I learnt more in my other classes. Although what I learned was different and exciting way of learning".

These comments and the descriptions in this and the preceding sections were intended to provide a range of ecological data on the classrooms we studied. The information provides the background canvas for the results reported in the subsequent chapters of this report.

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4. VARIATIONS IN THE ENVIRONMENT OF THE CLASSROOMS

4.1 Introduction

In this chapter we report on a number of associations and variations in the environment of the self-paced science classrooms. We report on the nature of the associations and variations, their determinants and effects.

How the "atmosphere", "climate" or "press" of schools and classroom environments has long been employed in discussions and comparisons of educational institutions. These mystical qualities of environments are the result of a series of interactions over time among a unique mix of persons and their behaviours. Whereas factors from within and without the school ensure that classroom environments have much in common, individual pupils and teachers do differ in the ways they relate to each other and to the planned experiences of the curriculum. These variations give classrooms, and schools, a distinctive quality characteristic of the particular learning environment. The study of these learning environments, their nature and their impact on instructional outcomes has been of major interest to educational researchers.

Measuring the nature of classroom environments, and especially those where open, self-paced or inquiry centred teaching occur, has proved to be a difficult problem. The environments are complex social settings which contain demands and constraints that are inherent in their nature given existing goals, structures and resources (Westbury, 1973). Valid descriptions of these environments are required if we are to understand how to cope with them and how to foster pupils' learnings in the settings. Among the most popular techniques for assessing these environments are the observational schedules for classroom behaviour and the self-report questionnaires for pupils. At present there are of the order of 120 observation systems, but, the majority of these have been developed with (i) little regard for each other, (ii) a narrow conception of reliability, (iii) minute attention to an underlying theoretical basis, and (iv) scant concern for construct, predictive or any other type of validity. Surprisingly, a number of successes have been achieved with these schemes, but, it must be recognised that these successes will contain limitations. For instance, pupils have longer experiences of the learning environments than a visiting researcher and their perceptions of their learning environment may provide a more valid description of the nature of the learning settings. Certainly some educational psychologists who favour field theories stress that this perceived environment, though subjectively constituted by each pupil, is the real environment for the individual and is a strong determinant of his classroom behaviour. The two well-known techniques for measuring pupils' perceptions of their environments are those devised by Anderson (1971) and Steele, House and Kerins (1971). Their ....

instruments, respectively the Learning Environment Inventory (LEI) and Class Activities Questionnaire (CAQ) measure different and similar dimensions of a learning environment but have rarely been used in the one study. In this chapter we report on our experiences with both instruments.

It is intriguing to note that research workers who are interested in the nature and impact of learning environments have rarely, if at all, attempted to discover whether there is any congruence between results obtained from observation schedules and pupil perception questionnaires. In fact, at the moment, we know relatively little about the relationships between measures of classroom environments deriving from systematic observations and those stemming from the reported perceptions of pupils. In this paper we report on some of these relationships.

Other factors are also of interest in studies of learning environments. Not only is attention focussed on descriptions of how classroom environments differ, but on those factors which give rise to variations in the environments. Among the determinants which have been studied are the curriculum, class size, grade level, initial properties of the class and the personality of the teacher (Anderson and Walberg, 1974). Other studies have sought links between variations in facets of the classroom learning environment and certain instructional outcomes (Anderson and Walberg, 1974; Dunkin and Biddle, 1974) but most of this research has occurred in conventional classrooms. There have been relatively few attempts to study the nature, determinants and effects of variations in those learning environments where self-paced curriculum materials are used. This is a curious omission, especially in view of the fact that during the past two decades there has been considerable interest in self-pacing, inquiry-centred teaching and open-plan education, and the associated curricula which are intended to foster these three styles of education and teaching.

4.2 Nature and Determinants of the Environment of Science Classrooms.

4.21 A.S.E.P. and Conventional Classes Compared

Data derived from the analysis of the 40 videotaped lessons on "How Many People" are presented in Table 4.1. For comparative purposes, the data from the 63 lessons videotaped in our earlier (Tisher and Power, 1973) study of A.S.E.P. classes in which the A.S.E.P. unit "Light Forms Images" was used, and from a study of 20 conventional science lessons (Power, 1971) are presented.

Regardless of the A.S.E.P. curriculum unit used, the overall patterns of interaction in the A.S.E.P. classes were remarkably similar. In both cases, classrooms were characterised by high levels of pupil activity, with the pupils as the source and the target of most interactions. The types of activities and the functions and processes involved in these were also similar, except that pupils using the unit "Light Forms Images" were involved in far more experimentation than those using "How Many People", while the latter pupils engaged in much more small group discussion and exchanges of ideas. Self-paced curriculum materials like A.S.E.P. then, seem to operate as important determinants ....

TABLE 4.1

Mean percentage time spent on behaviours in ASEP and conventional science classes

Behaviour Category	Conventional Science Classes	ASEP Classes	
		Light forms images	How many People
Source of Activity			
-pupil	19	61	55
-teacher	73	35	37
Target of Activity			
-pupil	9	28	47
-class	65	14	12
-teacher	1	7	12
-material	4	48	24
Interactions			
P - M	3	46	19
P - T	1	7	10
P - P	1	6	21
T - M	1	2	4
T - C	65	13	11
T - P	8	22	23
Activities			
No activity	8	6	7
Questioning	25	13	30
Informing/ directing	37	24	41
Writing	*	5	9
Experimenting	5	34	7
Observing	*	13	9
Reading	*	7	5
Functions			
Fact stating	48	6	10
Describing	6	9	4
Interpreting	4	2	4
Explaining	18	1	17
Purposes	*	1	3
Procedures	2	21	18
Difficulties	*	1	1
Progress	*	3	4
Positive Affect	0.2	1	2
Negative Affect	0.2	0.5	0.4

* Data not collected in this study by Power (1971)

TABLE 4.2

Mean item scores on LEI and CAQ scales for ASEP classes using "How Many People"

Pupils' Perceptions	Pre-test	Post-test	Sig. level
LEI Scales			
Cohesiveness	2.81	3.02	**
Diversity	2.84	3.11	**
Formality	2.58	2.75	*
Speed	2.63	2.50	*
Environment	2.26	2.33	
Friction	2.80	2.80	
Goal direction	2.40	2.67	**
Favouritism	2.36	2.18	*
Cliquishness	2.86	2.98	*
Satisfaction	2.27	2.40	*
Disorganization	2.68	2.45	*
Difficulty	2.67	2.67	
Apathy	2.68	2.42	*
Democratic	2.26	2.35	
Competitiveness	2.53	2.58	
CAQ Scales			
Independent inquiry	2.42	2.47	
Indifference	2.45	2.25	**
Humour	2.20	2.70	**
Cramming	2.66	2.62	
Interpretation	2.60	2.60	
Participation	2.40	2.50	
Translation	2.65	2.60	
Information processing	2.73	2.73	

** Sig. at 0.01 level

* Sig. at 0.05 level

of classroom behaviour. The A.S.E.P. units demand a high level of student activity, the nature of which depends on the activities assigned within the unit. On the other hand, in the conventional setting where the materials used do not of themselves constitute a set of carefully sequenced pupil activities, the teacher, rather than the materials, or the pupils, is the source and director of most activity, and the dispenser of information. Of course, in those situations where a major text is used it will sequence a great deal of the instruction.

4.22 Changes in Perceptions.

What are pupils' perceptions of their A.S.E.P. learning environment? and do these perceptions differ from those the pupils had in a more conventional learning setting? Table 4.2 contains the relevant data. The last three columns show the mean score per item for each LEI and CAQ scale on the pre and post-testing, and the significance level of the differences between the respective administrations (the class mean was taken as the unit of analysis). Note, however, that we found it necessary to revise some of the items in the post-test because Grade 9 pupils experienced some difficulties in reading and interpreting test items. These changes may create some problems in using the data in Table 4.2, but, with the caution noted we present some interpretations. It does appear that compared to their earlier conventional science lessons, pupils perceived their A.S.E.P. learning environment as more cohesive, diverse, formal, goal directed, cliquish, satisfying and involving more humour and discussion of interesting ideas than before. Also, it was characterised by less speed, favouritism, disorganisation and apathy.

The introduction of a set of individualised curriculum materials did produce significant and profound changes in the patterns of interaction in the classroom and in the way in which pupils perceived the classroom environment - at least in the short term.

From our perspective, most of the observed changes were gratifying, since we consider it desirable that pupils come to know one another better, to be more diverse but at the same time more goal directed and more involved, and for classes to be better organised and less rushed. But we were at first a little surprised to discover that pupils perceived A.S.E.P. classes as somewhat more formal. However, the LEI formality scale measures the extent to which there are clear standards governing behaviour in the classroom rather than measuring formality in terms of any classroom rituals. In an activity-oriented programme it is expected that there will be explicit overt guidelines to regulate pupil activity, particularly if accidents and chaos are to be avoided. Consequently, in these settings pupils can be expected to perceive their environment as a more formal one.

Pupils also perceived the change to A.S.E.P. as producing more cliquishness in class. Probably this change is a natural consequence of allowing pupils to work together in small, self-determined groups. But even so, the A.S.E.P. classrooms were regarded as more cohesive than the conventional ones.

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It might be expected that the A.S.E.P. classrooms would be perceived as more inquiry-centred than the conventional classes, but this was not the case. This observation is consistent with the observational data (Table 4.1) which indicates that the A.S.E.P. ("How Many People") classes, although involved in more small group discussions, engaged in a comparable amount of experimentation to the conventional ones.

4.23 Associations between perceptions, behaviours and pre-test measures.

Given that the particular set of curriculum materials used operates as a frame factor within which the classrooms can vary, what else affects the environment of the A.S.E.P. classrooms? We were interested in a number of initial properties (measured by our pre-tests) and the teachers' beliefs about the teaching process. Correlations among some of the measures, the observed patterns of classroom behaviour and pupils' perceptions of their environment are presented in some of the following tables. Tables 4.3 and 4.4 for example, contain data on the associations between certain initial properties of the classes and observed behaviours and pupils' perceptions. The class was the unit of analysis.

Tables 4.3 and 4.4 indicate that the initial properties of the classroom group profoundly influenced the patterns of interaction in the A.S.E.P. classrooms and the classes' perceptions of their learning environment. When the initially bright, science oriented classes are compared with the other classes using "How Many People" their learning settings had the following characteristics:

(i) a relatively higher proportion of time spent on group activities, teacher initiated interactions with individuals and groups, questioning,

(ii) a relatively lower proportion of time spent with the teacher directing the class as a whole, doing nothing or engaged in task irrelevant activity, expressing negative affect, experimenting,

(iii) an environment perceived as more cohesive, goal directed, competitive, and involving more humour, participation, satisfactions and oriented towards complex cognitive behaviour,

(iv) an environment perceived as less formal, apathetic, indifferent and concerned with individual status and attention.

4.24 Pre-tests and perceptions : Canonical Analysis.

Relationships between the set of pre-test measures and the perceptions of the environment of the 315 pupils involved in this study were determined using canonical analysis.* Table 4.5 shows the correlations between the original variables and the canonical variate, the canonical correlations and their probabilities for the two significant relationships found. The data indicate that:

(i) a cluster of pre-test variables including ability, prior knowledge and satisfaction with the existing science program covaries with pupils' perceptions of the extent to which they were active and willing participants in well organised enjoyable activities.

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* The same technique could well have been used in the preceding analysis had the number of classrooms involved been sufficiently large.

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TABLE 4.3

Correlations between initial class properties and observed behaviour

Observed behaviour	Inter D	Achievement * 1	Achievement * 2	Attitude 1	Attitude 2	Attitude 3	Satisfaction 1
Source							
- group	58	40	50	05	19	13	17
Target							
-group	49	49	39	07	09	31	26
-class	-52	-46	-51	-22	-03	-27	-11
Interaction							
T - C	-50	-43	-50	-21	05	-29	-11
T - P	59	65	48	32	35	11	16
Activities							
No activity	-65	-55	-51	-21	-32	-35	-57
Questioning	45	40	25	11	36	-06	17
Directions	-52	-56	-27	-11	-27	13	-16
Reading	11	28	16	54	48	29	18
Functions							
Purposes	-16	-23	-07	-06	-46	07	18
Procedures	-12	00	-10	21	45	04	-26
Task Irrelevant	-43	-45	-31	-21	-53	-24	-76
Negative Affect	-42	-52	-08	-06	-20	17	-09

Note: In Tables 3, 4, 6, 7, measures are excluded if correlation < 0.44. Coefficients ≥ 0.44 sig. 0.05 : ≥ 0.56 sig. at 0.01 level.

* **Note**: Achievement 1: understanding of ecology
" 2: " " population evology
Attitude 1: attitudes towards pollution
" 2: " " population
" 3: " " resources
Satisfaction 1: course interest
" 2: perceived learning
" 3: social organization

(ii) a cluster of pre-test variables including ability, prior knowledge and dissatisfaction with the existing program covaries with pupils' perceptions of the degree to which the A.S.E.P. environment is seen as lacking in formality, goal direction and satisfaction.

The canonical analysis indicates that an individual's perception of the A.S.E.P. learning environment is not markedly influenced by his characteristics at the point of entry to the program. The redundancy measure* for the set of environmental variables, given the set of pre-test variables, was only 0.06. Inspection of the original correlation matrix reveals that few correlations between an individual's pre-test and environmental measures exceed 0.3. It would seem then that while the environment of a class was very much dependent on the entry characteristics of the class as a group, the perceptions of individual pupils are only marginally related to their entry characteristics.

TABLE 4.4

Correlations between initial class properties and perceptions of environment

Pupils' Perceptions	Inter D	Achievement 1	Achievement 2	Attitude 1	Attitude 2	Attitude 3	Satisfaction 1
Cohesive	36	46	36	07	21	10	43
Formality	-24	-06	-24	-31	-25	-44	-04
Environment	15	19	20	27	31	21	45
Goal Direction	16	17	00	-21	04	-16	45
Favouritism	-37	-25	-22	17	-18	-03	-51
Satisfaction	22	15	-5	-12	15	-02	63
Apathy	-60	-51	-32	-20	-38	-12	-57
Competitiveness	49	43	28	09	36	24	30
Indifference	-42	-45	-32	-28	-31	-33	-67
Humour	62	53	59	42	57	55	52
Cramming	52	50	32	28	43	14	37
Participation	40	44	28	21	11	08	49
Translation	44	37	38	52	31	41	32
Information process	55	63	43	24	38	16	46
Individual concern	-66	-47	-44	-23	-34	-28	-36

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* Note, however, that Darlington et.al. (1973) argues that this redundancy measure is not an exceptionally good index. They suggest some other... procedures)

TABLE 4.5

Results of canonical analysis between pre-tests as predictors and perceptions of environment as criteria.

Variables	Structure coefficients Factor 1	 Factor 2	Canonical Weights Factor 1	 Factor 2
Predictors				
Inter D	48	73	26	60
Achievement 1	49	50	33	23
2	51	52	12	22
Attitude 1	18	05	-19	-02
2	28	06	04	09
3	31	16	-09	21
Satisfaction	85	-45	87	-70
Criteria				
Cohesiveness	46	-06	31	07
Formality	04	-53	-15	-34
Goal direction	37	-48	-04	-29
Satisfaction	58	-54	32	-65
Disorganization	-51	-10	-19	-28
Apathy	-63	-09	-34	-30
Indifference	-64	07	-45	-02
Information Process	46	-06	20	09
Canonical R	60	48	**Redundancy**:	
Canonical R^2	36	23	Predictors given criteria 0.16	
Probability	.0001	.0001	Criteria given predictors 0.06	

Note: Structure coefficients are correlations of original variables with canonical variates.

Only criteria with larger structure coefficients shown.

4.25 Associations between teachers' beliefs and classroom behaviours.

A survey of the research literature and a general consideration of the nature of educational systems, and the specific learning settings within these, provide support for the notion that teachers are one of the main sources of stability within schools (Reid, 1975). Note that the central activities of teaching have been visible to all members of the teaching profession (and the community), for a considerable length of an individual's life. The ideas formed through numerous significant contacts are hard to unlearn. Unfortunately, alternative teaching models which are presented by teacher educators and/or curriculum designers frequently

> "tend to lack authority and to be discarded rapidly in the face of teachers' needs to adjust to the value systems of the schools where they must shape their careers. Hence teachers tend to promote stability rather than to challenge it".
>
> (Reid, 1975. p.249)

It is also the case that organisational variables such as the physical environment of the school, the demands and constraints of the school administrators and the nature of support facilities also shape the range and characteristics of learning activities. But, given a degree of similarity across schools for these last mentioned variables, to what extent are the beliefs of teachers associated with the characteristics of learning activities in classrooms where identical self-paced learning materials are used?

Table 4.6 contains information on the significant associations between the teacher values (a maximum of 14) and the behaviour variables (a maximum of 36) used in our study. Note, that 504 correlations can be derived of which 56 were found to be significant at the 0.05 level. However, we would expect 25 of these to be significant by chance alone, so the information presented in the table must be interpreted circumspectly. Furthermore, although the significant correlations in Table 4.6 imply that the variance in a behaviour in the sample of classes using ASEP is associated with a variation in the value (or belief) patterns of the teachers, it cannot be claimed that variations in teacher beliefs caused variations in observed behaviour.

The data in Table 4.6 can be interpreted to indicate that in the classes of those teachers who place a premium on the social and personal development of their pupils, on pupil inquiry in lessons and on activity in small groups there are

- greater numbers of initial and follow-up questions,
- fewer occasions of positive affect,
- fewer activities involving the discussion of procedures and progress in the learning tasks,
- fewer occasions involving writing and observing, and
- fewer instances in which the teacher consulted the text or other curriculum materials.

TABLE 4.6

Association between Teachers' beliefs and Classroom Activities

Teacher Belief / Behaviour Category	SOCIAL AND PERSONAL DEVELOPMENT	CONVERGENT ACTIVITY	RULES AND DISCIPLINE	CONCEPTUAL SCHEMES	CURRICULUM DEPENDENCY	INTRINSIC MOTIVATION	TEACHER-CENTRED APPROACH (A)	DEPTH ORIENTATION	BEHAVIOUR ORIENTATION	SMALL GROUP INVESTIGATION	INQUIRY ORIENTATION	HUMANISTIC VALUES	PROGRESSIVE
Source of Activity													
Group	49	50	-53			-59	69						
Teacher				45	-48				-56				
Target of Activity													
Group													
Materials				49									
No target												-48	-5
Interactions													
P - M		52	-50	45									
P - T	46												
P - P						-47							
T - M	-77						-44		56	-51	-55	-51	
Activities													
Questioning (Q)	44									53			
Follow-up Q. (Q')			55							44			
Writing	-77						-48		73		-71	-64	-5
Experimenting												-44	
Observing	-77			-46					44		-56	-49	
Functions													
Fact-Stating		-54											
Interpreting				-52									
Procedures	-69								56	-43	-50	-49	
Progress	-80						-52		54	-48	-61	-66	
Task Irrelevant								50				-49	
Positive Affect	-50			-47					46				

$r \geq 0.44$ $p < 0.05$

On the other hand, in those classes where the teachers place a high premium on rules and discipline, and in lecturing and controlling activities there are

less group activities,
less manipulations of materials by pupils but more by teachers,
more follow-up questioning,
more pupil-pupil interaction,
more writing and
more occasions involving the discussion of progress in the learning tasks.

Also, in the study, those teachers who believed that a greater emphasis should be given to the fundamental ideas (conceptual schemes) of science had classes which were characterised by more teacher talk (teacher as source), a greater number of interactions between pupils and the materials, and fewer occasions of observing, interpreting and positive affect. The data in Table 4.6 indicate that whereas there is more structured and directed activity in classes taught by teachers who believe a science course should reflect the structure of modern science, there is more task irrelevant activity in those classes taught by teachers who believe in the development of a small number of key ideas and topics.

Teachers who believe that learning should occur largely as a function of the interaction between pupils and the curriculum materials without the aid of the teacher (curriculum dependency) were less often the source of interaction with the pupils. However, the frequencies of pupil-pupil interactions and the occasions when groups were the targets of activities were associated with the value placed on intrinsic motivation by the teacher. The greater the emphasis on intrinsic motivation the lower were the previously mentioned two categories (c.f. too the discussion on pupils' perceptions).

Teachers who stated that they rarely encouraged pupils to decide on the correctness of an answer, or probed answers and who reinforced answers (behaviour orientation), did in fact appear to follow these practices in the ASEP lessons. There was no significant amount of follow-up questioning in their classes and more time was devoted to recording information, positive reinforcement and the discussion of procedures and progress in the learning task. On the other hand, those teachers who placed a high value on small group investigation (e.g. first hand experiences, observation, inquiry in small groups) spent less time than the "behaviour orientation" teachers in consulting curriculum materials and discussing procedures and progress. However, they asked more questions and probed pupils' answers.

Overall, the patterns of relationships between teachers' beliefs and the activities in their classrooms are fairly consistent with those of our earlier study (Tisher and Power 1973). The teachers appear to foster activities which are congruent with their beliefs about teaching. For example, in those classes taught by teachers who valued an inquiry-centred approach to science, both pupils and ...

teachers were more actively and intimately involved in lessons, and they appeared to be more concerned with the processes of inquiry than with following a recipe which would lead to an answer. Those teachers who placed a high premium on humanistic values, while not markedly different from the inquiry-centred ones, did place somewhat less emphasis on experimentation and physical activity which appears to have resulted in more group discussions of which not all were relevant to the learning task.

4.26 Associations between pupils' perceptions and classroom behaviours.

Note that learning environments have been described in terms of behaviour categories which belong to a specific coding scheme, or in terms of categories which belong to a scheme for measuring pupils' perceptions of their learning environment. The validity of the approaches is usually justified by the reporting of associations between the separate behaviour and perception measures and certain criterion measures such as pupil achievement. However, an intriguing and inadequately researched question is to what extent are pupils' perceptions of their learning environments congruent with the classification of these same environments obtained from a coding scheme such as SABIC? Table 4.7 contains details of the significant associations for the measures used in our study. The rows refer to the categories of the SABIC coding scheme and the columns to the scales in the Learning Environment Inventory, Class Activities Questionnaire (CAQ) and three additional scales labelled involvement, initiation and concern. The first twelve columns refer to some of the learning environment scales.

About 16 per cent of the correlations between the behaviour scales and CAQ scales were significant, compared with 8 per cent for the LEI and behaviour scales. Note that 5 per cent of these correlations could be expected to occur by chance alone. These results are not exciting. Certainly for those persons who anticipated greater associations (or congruence) between the two approaches to measuring learning environments the information in Table 4.7 is discouraging.* From another viewpoint it may be argued that the validity of one, or another, of the schemes is in question. However, the rationale for the construction of the SABIC scales was not identical to that used for establishing the LEI and CAQ, so some persons may wish to take a more optimistic interpretation of the results in Table 4.7. In this case there are some encouraging associations between scales and some of these are discussed below. But, first, it is appropriate to note that many of the perception scales are highly inter-related. For instance, inter-correlations of mean class scores on cohesiveness, apathy and goal direction (between 0.69 and 0.91) indicate that pupils who rate their classes high on one tend to rate it high on the other two. Ratings on friction, favouritism and cliqueness are also closely inter-related

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* In a personal communication Herbert Walberg observes that neither Steele, Anderson or Walberg would expect congruence.

TABLE 5.7

Association between Observed Behaviour (SABIC Category) and Pupils Perceptions of their Environment

Pupils' Perceptions / SABIC Category	COHESIVE	DIVERSITY	ENVIRONMENT	FRICTION	GOAL DIRECTION	FAVOURITISM	CLIQUENESS	SATISFACTION	DISORGANISATION	DIFFICULTY	APATHY	DEMOCRATIC	INDEPENDENT ENQUIRY	INDIFFERENCE	HUMOUR	CHARMING	INTERPRETATION	PARTICIPATION	TRANSLATION	INFORMATION PROCESSING	PARTICIPATION	INITIATION	CONCERN
Source of Activity																							
Pupil		55																					
Teacher		-54																			52		
Target of Activity																							
Pupil										44													
Group													54	-57				52		46			-60
Teacher																						57	
Interactions																							
P - P													43										
T - M																-47	-46						
T - C																			-44		63	50	54
T - P	43		-44														48		46	58		-50	-48
Activities																							
Informing	49				51			44	43		-56		54	-46		57	61	56		57			
Directing											62					45	-53		-51				
Experimenting					-48	46		-49					-51	55		-46	-55	-44	-51	-61			
Observing																-46							
Reading			44																				
Ques.-Ans.															45								
Functions																							
Interpreting		46																					
Explaining								45															
Procedures																					50		
Difficulties				-44						48											-51	-52	
Task Irrelevant					-53	47		-65	53		73	-45	65	-49	-61	-54	-59		-63				
Positive Affect		52																					
Negative Affect	-53			44	-54		45	-48	61		57				-49		-49		-55				

$r \geq 0.44$ $p < 0.05$

(between 0.74 and 0.85) and are consistently negatively related with cohesiveness, satisfaction and goal direction (between -0.68 and -0.85)

An inspection of Table 4.7 reveals that the classes of pupils who perceived their learning environment as cohesive (and co-operative) were classified as ones involving more teacher-pupil interactions, more information giving and less negative affect. Similarly more information giving and less negative affect was observed in classes where pupils rated the learning environment as more goal directed. In these classes there was also less experimentation and fewer irrelevant behaviours.

There was a high inter-correlation between disorganisation and apathy (r = 0.84) and in those classes where these two features were rated high there were greater numbers of task irrelevant activities, more negative affect and less information giving. It is also of interest to note that where pupils perceived the learning environment as difficult, more time was devoted to discussion of difficulties. Where pupils perceived their environment as a satisfying one, more time was devoted to information giving and explaining and less to task irrelevant activities and criticism (negative affect). These findings are indeed encouraging and indicate there is some validity in some of the two sets of scales - SABIC and LEI.

With respect to the CAQ scales and SABIC categories there were, as noted earlier, a greater number of significant inter-correlations which indicate we had greater success in relating CAQ scales and SABIC categories. There are some intriguing associations! For example, in those classrooms where the pupils perceived they had little opportunity to participate in discussions and where they did not enjoy the ideas studied ("Indifference") more time was devoted to experimenting and less to informing! However, there were significantly more task irrelevant activities. Evidence which is accruing from a study of the sequences of activities indicates that for a reasonable proportion of class time pupils in ASEP classes discuss out-of-school social and sporting experiences.

In those classes which were perceived to be more inquiry centred there were more pupil-pupil interactions, fewer task irrelevant activities but, curiously, less experimentation and more information giving. In those classes where there was more concern for grades and memorizing information ("cramming") there was in fact less time spent on experimenting and task irrelevant activities, but more on informing and directing. Where pupils perceived their learning environment as allowing them to build on answers and go beyond given information (Interpretation) there was, in fact, less experimenting, more informing, less directing and less task irrelevant activities.

Table 4.7 shows that in those classes where pupils perceived they can put ideas to use and engage in logical reasoning and analysis ("Information Processing") there was more teacher-pupil interaction, more information giving, less experimentation and fewer task irrelevant activities. However, overall, we are left with a mixed picture of the associations between pupils' perceptions of their learning environment and the nature of these environments as obtained from the SABIC measures. Certainly there is no startling congruence between the two sets of measures. One implication of this is that in any studies of classrooms and the effectiveness of teaching strategies, it is essential that both measures of pupils' perceptions and behaviour categories are included. A more pessimistic implication is that both sets of measures are not very useful anyway! Whether this is the case is discussed where we report on the associations between the previously mentioned two sets of measures and the criterion measures (e.g. achievement).

4.27 Associations between perception and criterion measures.

The usefulness and validity of the perception and behaviour measures must also be gauged in terms of their associations with the criterion measures. In a previous report (Tisher and Power, 1973) we discussed some of the significant associations between CAQ measures and criterion variables, but the number of these associations was low. This is also the situation in the present study with both CAQ and LEI scales.

TABLE 4.8

Associations between Pupils' Perceptions and Outcomes

Perception Measures / Criterion Measures	POST ACHIEVEMENT	POST ENVIRONMENT ATTITUDE	POST SCIENCE ATTITUDE
LEI Scales			
Cohesive		69	
Apathy	-55	-49	
CAQ scales			
Indifference		-48	
Humour	58	55	64
Cramming	57		
Interpretation	45		
Participation		50	
Translation	47		

$r \geq 0.44$

$p < 0.05$

Table 4.8 contains the details of the significant correlations between perception and criterion measures. Of the possible 184 correlations eleven were significant at the 0.05 level but of these nine could occur by chance.

Only two of the LEI scales correlated significantly with the outcome measures, compared with six from the CAQ. But of the eight significant correlations involving the CAQ only four involved achievement measures, the remaining four were between attitude measures and our three CAQ scales, indifference, humour and participation.

As may have been expected those classrooms which were perceived as allowing greater participation and as containing more humour, had pupils who scored higher on attitudinal measures. Also, where there was more humour, more translation of ideas, less emphasis on grades, pupils scored higher on the post-achievement test. Where pupils perceived there was little opportunity for enthusiastic discussion, they scored lower on attitudinal measures.

4.28 Association between classroom activities and criterion measures.

Table 4.9 contains details of the significant associations between the SABIC categories and the post-criterion measures. If attention is focussed only on those categories dealing with the types of behaviour and interactions (not on sources, targets and functions) then there are 152 possible correlations between the behaviour and outcome measures. Of these eight could be expected to be significant at the 0.05 level by chance alone. Thus the seven we report in Table 4.9 are not very exciting, to say the least.

TABLE 4.9

Associations between Classroom Activities
(according to SABIC)
and
Outcomes

Criterion Measure / SABIC Category	Post-Achievement	Post-Attitude (Environment)
Interactions		
T - C	-52	-56
T - P	65	64
Activities		
No activity	-70	-54
Information Giving		
Direction Giving	-59	

$r \geq 0.44$

$p < 0.05$

4.29 Association between teacher values and perceptions.

Teachers tend to behave in ways consistent with their beliefs about teaching (see previous discussion on the association between values and classroom behaviours). Are pupils' perceptions of their learning environment correlated with teachers' values? The data in Table 4.10 indicates that there are a number of significant associations.

TABLE 4.10

Association between Teacher Values and Pupils' Perceptions

Teacher Values / Pupils' Perceptions	CONVERGENT ACTIVITY	RULES AND DISCIPLINE	PROFESSIONALISM	CONCEPTUAL SCHEMES	INTRINSIC MOTIVATION	TEACHER-CENTRED APPROACH (R)	DEPTH ORIENTATION	SMALL GROUP INVESTIGATION	INQUIRY ORIENTATION	HUMANISTIC VALUES
LEI Scales										
Cohesive					-49					
Diversity						-52				
Formality					-52					
Speed							-46			
Environment		-51	-45		-49					
Satisfaction				-45						
Disorganisation					44					
Competition	-49									
CAQ Scale										
Independent Inquiry	-49									
Indifference					-66					
Humour				55	44					
Cramming						45			47	59
Interpretation							-45			
Participation		-58	-48		-48					
Translation					-49					
Information Processing			-45							
Initiation					51					
Concern								-50		

$r > 0.44$

$p < 0.05$

The only teacher value which appears to have the greatest association with pupils' perceptions is the teacher's belief in the efficacy of intrinsic motivation as opposed to the use of external rewards for satisfactory accomplishments. When taught by teachers who emphasized intrinsic motivation pupils perceived the learning environment as

(a) more disorganised, less formal and less cohesive,

(b) characterised by more humour, and less indifference on their part, and

(c) providing more opportunity to initiate activities but less opportunity to

 (i) engage in explaining, summarizing ideas and judging the worth of ideas ("Translation")

 and

 (ii) participate actively in discussions ("Participation")

Other significant associations (Table 4.10) occurred between

(i) a press towards convergence on the teachers part and a perceived lack of emphasis on inquiry by the pupils,

(ii) an emphasis on rules and control by the teacher and a perceived lack of opportunity for participation by pupils,

(iii) a belief in the usefulness of unstructured work sheets and appropriateness of in-service education ("Professionalism") and a perceived lack of opportunities for participation and a lack of emphasis on the recall and processing of information by pupils,

(iv) the greater stress on the development of a few ideas in depth by the teacher ("Depth Orientation") and pupils' perceptions of more stress on interpretation and a slower pace of working in class,

(v) a greater emphasis on pupil experimentation and small group activity by the teacher and pupils' perception of less concern and interest by the teacher in them as individuals,

(vi) a greater stress on keeping the class together ("Convergent Activity") i.e. a reduction of 'variance' in class, and a lower level of perceived competitiveness on the part of pupils (c.f. Dahloff 1971, Lundgren, 1972)

and

(vii) teacher's rejection of lecture-demonstrations, and question-answer teaching techniques ("Teacher-Centred Approach") and pupils' perceptions of greater diversity in class.

Over all the associations in Table 4.10 appear to be logically consistent and interpretable. Our personal knowledge of the classes, coupled with the findings presented above, indicate that there are a number of benefits which accrue in self-paced learning environments. There is an encouragement of diversity by the teachers as well as an emphasis on intrinsic motivation and experimentation by pupils with a consequent slowing down in the learning pace, less cramming of facts into pupils and more joking and laughter in class. But, when there is a great diversity in lessons, an increasingly greater amount of time is spent on directing activities and managing pupils. There also seems to be a greater demand or pressure on resources. Because of these features it seems reasonable to expect, (as we found above), that the pupils will see the teacher as one who is less concerned with them as individuals and the environment as one which provides less

6.
pportunity to engage in discussion of important issues and less opportunity or review.

TABLE 4.11

Results of canonical analysis between environment scales as predictors and post-test measures as criteria

Variables	Structure Coefficients Factor 1	Factor 2	Factor 3	Canonical weights Factor 1	Factor 2	Factor 3
Predictors:						
Cohesiveness	40	43	28	08	45	31
Formality	36	-08	-13	-17	17	-11
Speed	-01	36	-03	13	41	-06
Satisfaction	46	10	-22	11	10	-35
Disorganisation	-64	16	08	-20	27	-15
Apathy	-75	06	15	-56	-03	13
Indifference	-60	18	00	-32	09	-01
Humour	23	-29	26	09	-13	17
Translation	25	06	28	16	-09	23
Information Process	34	-05	32	02	-36	36
Criteria:						
Achievement 1	71	-12	24	49	-04	06
Achievement 2	57	-23	46	18	-18	39
Attitude 1	39	44	37	-14	38	25
Attitude 2	43	36	10	16	28	-21
Attitude 3	58	-18	15	32	-64	-02
Satisfaction 1	74	38	-35	74	-14	-44
Satisfaction 2	50	57	-33	-15	43	-36
Satisfaction 3	39	65	34	-05	34	65
Canonical R	53	48	44	**Redundancy:** Predictors given criteria 0.06 Criteria given predictors 0.17		
Canonical R^2	29	23	20			
Probability	0001	0001	0004			

* **Note**: Only predictors with larger structure coefficients shown.

4.3 Relationships between Environmental Measures and Outcomes.

The impact of variations in the classroom environment on the achievements, attitudes towards environmental issues and classroom satisfactions of individual pupils and classes were investigated using regression and canonical analysis techniques. The results of the canonical analysis are reported first followed by those from the regression analyses in which the pupil and the class were used as the unit of the analysis.

4.31 Canonical Analysis: Perceptions versus Outcomes.

In Table 4.11 the results of a canonical analysis linking pupils' perceptions of the classroom environment with individual outcomes are presented. Three significant canonical relationships were detected:

The first canonical function links a set of variables measuring the extent to which individuals perceive the classroom as a well-ordered place where pupils participate in interesting activities with a set indicative of higher achievement, more positive attitudes towards the environment and greater satisfaction with the ASEP unit and its approach. The link parallels that found between pre-test measures and pupils' perceptions of the environment (c.f. Table 4.5, canonical relationship 1). Together the two sets of results suggest the existence of a "success syndrome" similar to that found operating in more conventional settings (Power, 1971); that is pupils who prior to the introduction of the ASEP unit were "bright" and satisfied, tend to perceive the new type science learning and the new environment in "rosy" terms: they continue to succeed and to enjoy their science experiences.

The other two canonical relationships are more difficult to interpret, which is not surprising given the low correlations between the original variables and the derived canonical variates. The second relationship seems to imply a link between the degree to which pupils perceive a pressure on the class to "keep up" on the one hand and pupil satisfaction with the ASEP approach (especially its social organisation) on the other. A third canonical relationship exists between what seems to be a higher cognitive press in the environment with the achievement of (cognitive and affective) goals at the expense of satisfaction with the content of the unit.

4.32 Regression Analyses: Environment and pre-test measures versus outcomes.

(i) Pupil as the unit of analysis (N = 315)

What contribution does a knowledge of how an individual perceives his learning environment make to explaining the variance in instructional outcomes, over and above that accounted for in terms of his entry characteristics? To help us in this question a series of regression analyses were conducted with the seven pre-test scores and the 26 environment measures as predictors and pupil achievements in ecology, attitudes towards the environment and satisfactions with the ASEP approach as criteria. The results are presented in Table 4.12.

The table indicates that the addition of the environmental measures did not add significantly to the explained variation in achievement, attitudes towards the population explosion or towards the wise use of resources. LEI and CAQ measures did make a small but significant contribution to the explained variation in satisfaction with the ASEP approach and to attitudes towards pollution. When partial correlations between the various environmental scales and outcomes

TABLE 4.12

General predictability of instructional outcomes from pre-test and environmental measures

Outcome Measure	Percent learning variance predictable			
	Pre-tests alone	Environment alone	Pre-tests + Env.	Increment due to Env.
Achievement:				
1. Ecology	32**	18**	40**	08
2. Population/ ecol.	35**	15**	41**	06
Attitude:				
1. Pollution	11**	14**	23**	12*
2. Population	14**	12	23**	09
3. Resources	21**	13*	27**	06
Satisfaction:				
1. Interest	10**	23**	27**	17**
2. Learning	04*	19**	22**	18**
3. Organization	05*	18**	21**	16**

* $p < .05$ ** $p < .01$

(with pre-tests held constant) were calculated, the most consistent (though weak) relationships with residual outcomes were between cohesiveness, goal direction, satisfaction (positive), favouritism and apathy (generally negative). (see Table 4.13)

TABLE 4.13

Correlations and Partial Correlations (with pre-tests constant) between environmental scales and post-tests.

Environment Scale	Achievement				Attitude						Satisfaction					
	1		2		1		2		3		1		2		3	
	r	r^1	r	r^1	r	r^1	r	r^1	r	r^1	r	r^1	r	r^1	r	r^1
Cohesive	07	00	08	02	26	28**	26	17**	20	09	13	19**	24	16**	31	29**
Diversity	07	01	03	-01	12	08	11	13*	14	03	08	-01	03	03	13	11*
Formality	-05	02	-12	-06	05	08	05	10	06	-03	-05	03	03	06	09	09
Speed	02	06	-04	-01	05	05	05	07	06	-02	-02	08	05	13*	12	13*
Environment	10	12*	00	-02	12	12*	12	07	09	07	08	08	10	06	10	08
Friction	-10	-08	-09	-05	-03	-03	-03	-09	-12	-02	-03	-22**	-23	-06	-06	-05
Goal direction	06	09	01	04	14	17**	14	13*	13	08	08	19**	21	19**	11	09
Favouritism	-13	-08	-16	-12*	-16	-15**	-16	-12*	-15	-03	-08	-11	-16	-02	-11	-07
Cliquishness	01	02	00	02	00	00	04	-03	-04	-03	-03	-04	-04	01	01	01
Satisfaction	06	03	00	-04	11	11*	00	06	07	09	12	21**	27	16**	11	07
Disorganis-ation	-21	-10	-13	00	-11	-07	-11	-07	-12	-17**	23	-17**	-23	-10	-08	-04
Difficulty	01	09	-07	-03	02	06	02	08	04	-01	-07	01	-04	04	11	15**
Apathy	-28	-18**	-13	05	-15	-10	-15	-10	-18	-15**	-24	-18**	-27	-14*	-08	-01
Democratic	06	08	-03	-02	01	02	01	00	01	08	09	08	09	-01	-04	-05
Competitive	14	07	09	02	02	00	03	-05	-01	06	00	-05	00	-03	06	03
Inquiry	08	07	-02	-04	06	05	06	08	09	08	11	02	06	03	09	06
Indifference	-16	-03	-15	-05	-08	-02	-08	-00	-07	-12*	-22	13*	-23	-08	-09	-02
Humour	16	12*	13	08	-01	-05	01	07	00	02	09	-06	-01	-09	00	-04
Cramming	15	06	07	-05	03	-02	03	01	09	06	14	-01	06	-02	02	-02
Interpret-ation	06	03	05	01	08	06	08	07	09	-03	01	-01	03	02	10	07
Particip-ation	16	09	08	01	12	07	12	05	10	12*	19	09	16	10	15	11*
Translation	07	03	10	09	14	10	14	06	09	09	14	04	08	04	14	11*
Information Process	16	07	11	02	11	07	11	08	13	09	16	-01	07	-05	13	08
Involvement	-09	-13*	-07	-08	-06	-07	-06	-08	-08	01	03	-12*	-10	-11*	-07	-07
Initiation	-10	-12*	-02	-04	-06	-05	-05	00	-03	06	06	-03	-02	-06	-07	-07
Concern	-12	-07	-08	-03	-05	-05	-06	-05	-06	11*	-04	-15**	-19	-17**	-07	-06

[r = correlation]
[r^1 = partial correlation]

* significant at the 0.05 level
** significant at the 0.01 level

Both individually and together the environmental measures contributed little to explaining the variance in the achievements, attitudes and satisfactions of individuals studying the unit "How Many People?" over and above that attributable to the pre-test measures. It should be noted, however, that pupils' exposure to the ASEP learning environment was quite brief.

(ii) Class as the unit of analysis (N = 20)

The contribution made by the environmental measures to the explained variance in class (not individual) outcomes is shown in Tables 4.14 and 4.15 where selected perception and behaviour measures are linked with outcomes. The variables in Table 4.14 were included in our first regression analyses since they correlated highly with outcomes measures. Subsequently other variables were placed in the regression equation and the significant results are reported in Table 4.15. As there were only a small number of units of analysis (i.e. 20 classes) the number of variables used in the regression models were restricted - a maximum of three predictors were included at one time.

A similar procedure was followed to that described earlier. A series of regression analyses were completed with the appropriate pre-test class mean, the 26 environmental measures and 36 behaviour measures as predictors, and class achievements in ecology, attitudes towards the environment and satisfactions with the ASEP approach as criteria.

The results in Table 4.14 indicate that in the case of achievement, most of the variance (80%) can be accounted for by the pre-test measure. The addition of the environmental variables class apathy, cramming, no activities, information giving and direction giving only adds a small, but significant increment to the explained variation in achievement. The picture is different with respect to variation in attitude. The environmental variables cohesiveness, teacher-class interaction, and teacher-pupil interaction account for a substantial amount of the variation in attitude while participation, no activities, information-giving and direction-giving contribute to a smaller, but still significant extent.

A relatively small amount (11%) of the variation in satisfaction can be attributed to the pre-test measure, prior-satisfaction. The only perception which contributed to a significant extent was that of humour. Note that a number of models which included two behaviours or perceptions along with the pre-test measure in the predictor set were set up. None of these models proved to be significantly better than the preceding set which contained only one behaviour or perception measure.

Table 4.15 contains data on the contribution made by the remaining environmental measures to the explained variance in the class outcomes of achievement and attitude. Most of the variance (80%) can be accounted for by the pre-test measure, but the addition of the measures diversity and apathy does add a small but significant amount to the explained variation in achievement. As was the case with Table 4.14 the picture is different with respect to variation in attitude ...

TABLE 4.14

Regression Analysis : Selected Class Perception and Behaviour Measures and Outcomes

Perception/ Behaviour Measure	Correlation			Proportion Criterion Variance Explained								
				Achievement			Attitude			Satisfaction		
	ACHT.	ATTITUDE	SATISF.	a	b	c	a	b	c	a	b	c
Perceptions												
Cohesiveness	33	69	19	80	80	00	28	68	40**	11	11	00
Apathy	-55	-49	-23	80	84	04*	28	40	12	11	11	00
Humour	58	55	64	80	81	01	28	38	10	11	41	30**
Cramming	57	27	42	80	84	04*	28	28	00	11	14	03
Interpretation	45	40	32	80	84	03	28	38	10	11	18	07
Participation	40	50	19	80	81	01	28	46	18*	11	11	00
Translation	47	37	09	80	81	01	29	29	01	11	11	00
Behaviours												
T - C	-51	-56	-21	80	81	01	28	49	22*	11	14	03
T - P	65	64	03	80	82	02	28	51	24**	11	11	00
No Activity	-70	-54	-34	80	87	07**	29	44	16*	11	14	03
Inform.Giving	37	35	17	80	85	05*	28	43	15*	11	12	01
Direction Giving	-58	-52	-19	80	86	06*	28	48	20*	11	13	02
Multiple												
Cohes; cram.				80	85	05	28	69	41**	11	15	04
Apathy;cram.				80	85	05	28	44	16	11	17	06
Cram.;particip.				80	84	04	28	48	20	11	15	04
Interp;particip.				80	84	04	28	46	18	11	25	14
T-C/No act.				80	87	07*	28	56	28*	11	16	05
T-C/Inform.				80	85	05	28	56	28*	11	14	03
T-P/Direct.				80	86	05	28	53	26*	11	16	05

Note: (a) Variance accounted for by appropriate pre-test alone.

(b) Variance accounted for by pre-test + behaviour/perception measure

(c) Increment due to behaviour/perception

* $p < 0.05$ ** $p < 0.01$ if increment significant.

where the appropriate pre-test accounts for 28 per cent of the variation and the perception measures (with the exception of diversity and apathy) contribute larger and significant increments to the explained variation. Note, too, that the three additional scales (participation, initiation and concern) which we generated are among the measures which add significant increments to the explained variation in attitude.

TABLE 4.15

Regression Analysis : Selected Class Perception Measures and Outcomes

Perception Measure	Correlation		Proportion Criterion Variance Explained					
			Achievement			Attitude		
	Achievement	Attitude	a	b	c	a	b	c
Diversity	0.13	0.28	80	84	04*	28	30	02
Friction	-0.06	-0.26	80	81	01	28	46	18*
Goal Direction	0.09	0.41	80	80	00	29	54	26**
Favouritism	-0.23	-0.40	80	80	00	28	45	17*
Cliquishness	-0.02	-0.21	80	80	00	28	43	15*
Dis-organisation	-0.33	-0.44	80	80	00	28	42	14*
Apathy	-0.55	-0.49	80	84	04*	28	40	12
Information Processing	0.55	0.61	80	81	01	28	50	22**
Participation	-0.24	-0.44	80	80	00	28	51	23**
Initiation	-0.32	-0.55	80	80	00	28	58	30**
Concern	-0.51	-0.56	80	81	01	28	64	16*

Note: (a) Variance accounted for by the appropriate pre-test alone.

(b) Variance accounted for by pre-test + perception measure.

(c) Increment due to perception measure.

* $p < 0.05$
** $p < 0.01$ if increment significant.

Now it is the case that the additions of perception and/or behaviour measures to the linear regression model do not produce large increments in the explained variance since most of the variation is already accounted for by the appropriate pre-test measure. Nevertheless, our findings do contain some, if not many, encouraging features despite the fact that a few writers (e.g. Marjoribanks, 1975) criticise the technique we have used as one which prevents the full character of the relationships between criterion, perception and behaviour measures being revealed. However, the criticisms do imply that other analyses should also be attempted in our search for a model which represents the complex relationships between the variables. In the next section we report on some of our explorations with other explanatory models.

4.4 Explorations : Non-linear Regression Analyses.

In the preceding regression analyses it was assumed that linear models were the most appropriate to account for the associations between the environmental measures and outcomes. However, theory (c.f. Good and Power, 1975) and research evidence (Anderson, 1970) indicate that this may not necessarily be the case. Given that different types of teachers and classroom environments can have differential effects on outcomes for pupils differing in ability, prior knowledge, attitude, perceptions, etc., what are the most useful models to account for the associations between the variables? Furthermore, can the contribution to the variance in pupil outcomes be accounted for more significantly by non-linear terms e.g. squared and product terms? We decided to explore the contribution of both types of terms. This exploration was a natural continuation and extension of our somewhat tentative explorations with curvilinear relationships in our previous report (Tisher and Power, 1973)

The first series of analyses were designed to test whether the addition of squared terms in the regression model produced significant increments in the explained variance of the outcome measure. The regression equation had the form

$$\underline{Z} = a B + bB^2 + cP + dP^2 + K$$

where Z = the predicted score on the criterion test,
B = a behaviour measure on SABIC
P = a perception measure on the LEI
K = a constant and the other terms are the coefficients.

This model was tested against one which had the form

$$Z = a B + c P$$

to determine whether the additional terms produced a significant increment in the explained variance. The results for two behaviour measures and a number of the LEI scales are reported in Table 4.16. This table shows that significant increments to the explained variance in achievement were obtained when squared terms were added based on teacher-class interaction and the perception measures apathy, democratic and competitiveness. Also a significant increment was obtained when the additional squared terms were derived from the SABIC measure on teacher-pupil interaction and the LEI scale democratic. The respective regression equations were computed to be

(1) $Z = 0.20 B - 0.01B^2 + 2.15P - 0.09 P^2 + 5.19$
(2) $Z = 0.13B - 0.01 B^2 + 13.78 P - 0.48 P^2 - 80.68$
(3) $Z = 0.04 B - 0.01 B^2 + 30.58 P - 0.93 P^2 - 231.17$
(4) $Z = 0.66 B - 0.01 B^2 + 11.72 P - 0.41 P^2 - 74.32$

TABLE 4.16

Regression Models : Squared Terms Included Selected Behaviour and Perception Measures and Achievement

Behaviour Measure	Perception Measure	Proportion of Criterion Variance Explained		
		I	II	III
T - C interaction	Cohesiveness	27	29	12
	Speed	27	27	14
	Friction	27	27	14
	Apathy (1)	27	51	16*
	Democratic (2)	27	27	20*
	Competitiveness (3)	27	56	17*
T - P interaction	Cohesiveness	42	42	10
	Speed	42	48	09
	Friction	42	42	11
	Apathy	42	54	07
	Democratic (4)	42	42	15*
	Competitiveness	42	56	11

Notes:

I Variance accounted for by the behaviour measure alone (linear model)

II Variance accounted for by the behaviour and perception measure (linear model)

III Increment due to the square terms for behaviours and perceptions.

* $p < 0.05$ if increment significant

Note, that the pre-test measure and/or ability measure were not included in the equations. These measures account for most of variance when included and in these explorations it was intended to seek out relationships between the behaviour and perception measures with the criterion. The various full regression models accounted for 31 to 73 per cent of the variance in achievement.*

Footnote: The regression analyses were based on measures derived from class means. As there were only 20 classes the findings for these analyses (where four predictors are introduced into the regression model) must be treated with some caution. However, the few successes we have had should encourage others to pursue this type of analysis with larger samples. In our other exploratory analyses the pupil was the unit of analysis.

The next step was to plot the regression surfaces generated by the preceding equations. As they each had the same sign for the corresponding coefficients it was decided to plot only one surface here. At the time of writing other computations are proceeding with other combinations of behaviour and perception measures. Figure 4.1 shows the regression surface for the first regression equation above, where the behaviour measure is Teacher-Class interaction and the LEI measure is apathy. The resulting surface looks somewhat like an aeroplane hangar set on a curved and sloping base. The regression surfaces for the other equations will be somewhat similar to that in Figure 4.1

Figure 4.1 shows that for a given level of teacher-class interaction there is an optimum level of apathy beyond which the achievement of the class decreases markedly. As a matter of fact, given the optimum level of perceived apathy, if the class measure is greater than this then increased teacher-class interaction has only a minor incremental effect on achievement. So the more pupils do not care about the future of the class, the less they care about what the class does and the lower their concern for the success of the class, provided that this "apathy" is greater than the specific optimum value, the lower will be the class achievement. For low levels, small increments in apathy are associated with increments in class achievement. When apathy is high, increases in teacher domination and control (i.e. increases in teacher-class interaction) only raise the achievement of the class by small amounts. Presumably in these situations pupils resent the domination by the teacher and do not respond with greater effort in the learning tasks.

Another approach we adopted in these exploratory analyses was to investigate the effect of the introduction of product terms into the regression equations. In this case the regression models we used had the form:

$$Z = aX + by + cxy + dy^2 + K$$

where Z = the predicted score on the criterion test,

X = ability or IQ measure obtained from the Inter D

Y = the measure on an environmental scale,

and the other terms are regression coefficients with K as a constant. Tables 4.17 and 4.18 show the results of the various non-linear regression analyses for the 26 environmental variables with total a achievement and total attitude as the criteria. The increments in the explained variance from the addition of the product and squared terms are also shown in these tables.

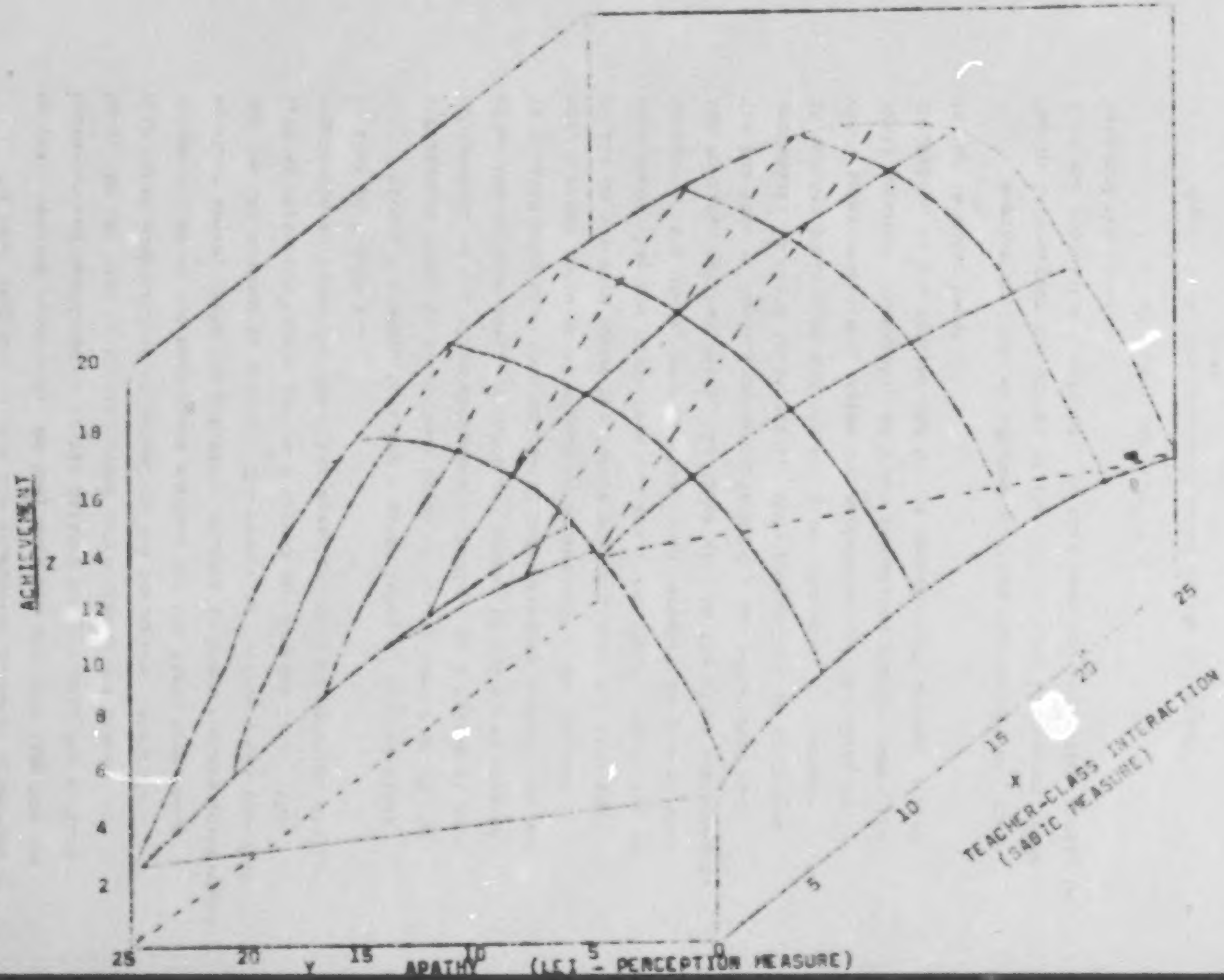


FIGURE 4.1

REGRESSION SURFACE FOR NON-LINEAR MODEL

TABLE 4.17: Nonlinear regression analysis: Perception Scales vs Achievement (N = 315 pupils)

Pupil Perceptions	Increment in variance				Total
	Linear		Interaction	Non-linear	
	IQ	ENV.	IQxENV	ENV.	R^2
Cohesiveness	247**	003	001	009*	260**
Diversity	247**	000	005	000	252**
Formality	247**	003	000	000	250**
Speed 247**	247**	000	001	001	249**
Environment	247**	003	000	011*	261**
Friction	247**	002	001	000	250**
Goal direction	247**	008	005	005	265**
Favouritism	247**	024**	000	005	276**
Cliqueness	247**	001	000	001	249**
Satisfaction	247**	008	002	003	260**
Disorganisation	247**	019**	002	006	274**
Difficulty	247**	002	000	001	250**
Apathy	247**	024**	001	001	273**
Democratic	247**	001	015*	000	263**
Competitive	247**	003	010*	004	264**
Independent inquiry	247**	004	000	000	251**
Indifference	247**	024**	001	001	273**
Humour	247**	015*	011*	002	275**
Cramming	247**	002	000	000	249**
Interpretation	247**	001	027**	004	279**
Participation	247**	024**	013*	022**	306**
Translation	247**	012*	031**	006	296**
Inform.process	247**	011*	001	015*	274**
Involvement	247**	006	012*	000	265**
Interaction	247**	016**	011*	002	276**
Concern	247*	003	010*	014*	274**

* $p < 0.05$ ** $p < 0.01$

TABLE 4.18: Nonlinear regression analyses: perception scales vs attitudes (N = 315)

Pupil Perceptions	Increment in variance				Total R^2
	Linear IQ	Linear ENV.	Interaction IQxENV	Non-linear ENV.	
Cohesiveness	042**	083**	001	000	126**
Diversity	042**	015*	013	000	070**
Formality	042**	008	008	004	062**
Speed	042**	010*	000	006	058**
Environment	042**	016**	000	000	058**
Friction	042**	013*	002	001	058**
Goal direction	042**	053**	000	000	095**
Favouritism	042**	026**	002	003	073**
Cliqueness	042**	000	004	003	049**
Satisfaction	042**	050**	005	000	097**
Disorganisation	042**	037**	000	002	081**
Difficulty	042**	000	007	000	049**
Apathy	042**	052**	004	000	098**
Democratic	042**	003	002	005	052**
Competitive	042**	000	002	020**	064**
Ind.Inquiry	042**	015*	001	016*	074**
Indifference	042**	033**	002	015*	092**
Humour	042**	000	003	000	045**
Cramming	042**	004	008	002	056**
Interpretation	042**	003	000	013*	058**
Participation	042**	039**	005	006	092**
Translation	042**	022*	011*	001	076**
Inform.Process	042**	012*	002	004	060**
Involvement	042**	011*	001	001	055**
Initiation	042**	003	003	001	049**
Concern	042**	025**	011*	009*	087**

* $p < 0.05$ ** $p < 0.01$

TABLE 4.19: Correlations and beta weights for non-linear regression analysis, perception scales vs achievement.

Pupil Perceptions	Linear Correlation		Interaction	Non-linear
	IQ	Env.	(Env.x IQ)	(Env.^{2})
	r(β)	r(β)	r (β)	r (β)
Cohesiveness	50(82)	11(-.59)	45 (-40)	12 (84)
Diversity	50(116)	02(47)	45 (-74)	02 (-15)
Formality	50(49)	-13(-05)	*	*
Speed	50(69)	40(-22)	-05 (-12)	-05 (24)
Environment	50(52)	06(-64)	42 (-03)	08 (71)
Friction	50(43)	-12(-31)	-11 (22)	35 (07)
Goal direction	50(81)	07(-13)	42 (-40)	08 (48)
Favouritism	50 (41)	-21 (17)	23 (10)	-21 (-41)
Cliqueness	50 (52)	01 (-22)	46 (-03)	01 (26)
Satisfaction	50 (66)	09 (-10)	42 (-22)	10 (34)
Disorganization	50(20)	-23(-91)	26 (32)	-22 (55)
Difficulty	50 (67)	-06(-21)	41 (-20)	-05 (26)
Apathy	50 (24)	-27 (-63)	27 (25)	-26 (31)
Democratic	50 (-19)	02 (-58)	44 (84)	03 (14)
Competitive	50 (106)	11 (-02)	44 (-74)	13 (47)
Ind. Inquiry	50 (45)	05 (-09)	07 (13)	44 (05)
Indifference	50 (33)	-23 (-11)	21 (18)	-24 (-19)
Humour	50 (107)	18 (14)	46 (-76)	18 (39)
Cramming	50 (59)	13 (-06)	46 (-12)	12 (16)
Interpretation	50 (133)	05 (19)	40 (-106)	08 (43)
Participation	50 (88)	18 (-13)	43 (-63)	21 (76)
Translation	50 (149)	11 (18)	45 (-119)	13 (55)
Inform. process	50 (79)	15 (-67)	48 (-39)	17 (98)
Involvement	50 (-05)	-08 (-50)	35 (70)	*
Initiation	50 (-01)	-14 (-27)	33 (64)	-14 (-24)
Concern	50 (53)	-12 (-29)	08 (-17)	-03 (42)

Values $r > .11$, $p < 0.05$, $r > .15$, $p < 0.01$

*F level insufficient to enter regression equation.

TABLE 4.20: Correlations and beta weights for non-linear regression analysis, perception scales vs attitudes.

Pupil Perceptions	Linear correlation		Interaction	Non linear
	IQ r (β)	ENV. r (β)	ENV x IQ r (β)	$(ENV)^2$ r (β)
Cohesiveness	20 (.35)	31 (139)	31 (-.22)	*
Diversity	20 (1.17)	12 (.36)	22 (-1.07)	13 (.20)
Formality	20 (-.49)	06 (.30)	23 (.74)	05 (-.55)
Speed	20 (.16)	08 (-.48)	22 (.07)	09 (.55)
Environment	20 (.08)	13 (-.06)	24 (.15)	13 (.09)
Friction	20 (.41)	-14 (-.17)	08 (-.25)	-13 (-22)
Goal direction	20 (.30)	22 (.22)	30 (-.11)	22 (.08)
Favouritism	20 (.39)	-18(-.28)	01 (-.27)	-16 (.33)
Cliqueness	20 (.87)	-02 (.90)	17 (-.72)	-02 (-.61)
Satisfaction	20 (-.11)	22 (-.05)	30 (43)	*
Disorganisation	20 (.19)	-23 (-.51)	01 (-.02)	-22 (.34)
Difficulty	20 (.86)	00 (.19)	17 (-.74)	01 (.17)
Apathy	20 (.05)	-27 (-.84)	-26 (.53)	01 (.12)
Democratic	20 (-.10)	05 (-.64)	20 (.37)	06 (.49)
Competition	20 (.49(	02(-.90)	16(-.39)	04 (1.11)
Indep. Inquiry	20 (-.08)	12 (-.85)	24 (.33)	14 (.79)
Indifference	20 (-.10)	-21 (1.06)	01 (.36)	-18 (.62)
Humour	20 (-.11)	00 (-.24)	17 (.41)	*
Cramming	20 (.02)	09 (.84)	21 (.19)	07 (-.88)
Interpretation	20 (.64)	07 (.03)	19 (-.56)	09 (.36)
Participation	20 (.45)	21 (.07)	26 (-.40)	22 (.42)
Translation	20 (.78)	15 (.74)	23 (.69)	14 (-.23)
Inform. process	20 (.50)	13(-.18)	23(-.39)	14 (.49)
Involvement	20 (.05)	-11(-.04)	10 (20)	-11 (-19)
Initiation	20 (46)	-06 (26)	12 (-33)	-06(-12)
Concern	20 (28)	-18 (-23)	-10 (-27)	-11 (34)

Values $r > .11$, $p < 0.05$; $r > .15$, $p < 0.01$

*F level insufficient to enter regression equation.

Tables 4.19 and 4.20 show the univariate correlations between each term and the criterion and the beta weights for each regression equation. These results are included for the information of readers, but, as yet, we need to interpret the meanings of the mass of information. One other procedure we have adopted was to plot contour regression surfaces similar to those shown in figures 4.2 and 4.3. In these figures the numerals on the contour lines indicate predicted achievement, in SD units, and the axis refer to ability and environment measures. In figure 4.2 the environment axes refers to the environment measure on the L.E.I., i.e. the measure which indicates the extent to which pupils perceive materials and equipment as readily available and take a pride in their classroom. Figure 4.2 indicates that achievement is lowest when low ability pupils rate the environment as "intermediate" and is maximised for all pupils when the environment is perceived as either very enriched or very poor!!

As indicated above, our explorations and interpretations with the various non-linear models are still proceeding, but we are reporting our results thus far in the hope that others will also continue with this large task. Now, there is yet another procedure which could be followed - one which has been suggested to us by Herbert Walberg in private communications. He believes we should attempt all the regression analyses again using medians instead of class means in all our equations. It is likely that these measures may provide more interpretable analyses and yield a greater number of successes than the preceding techniques. To date we have not implemented his suggestion as we have had more than enough regression models to test.

4.5 Concluding Comments.

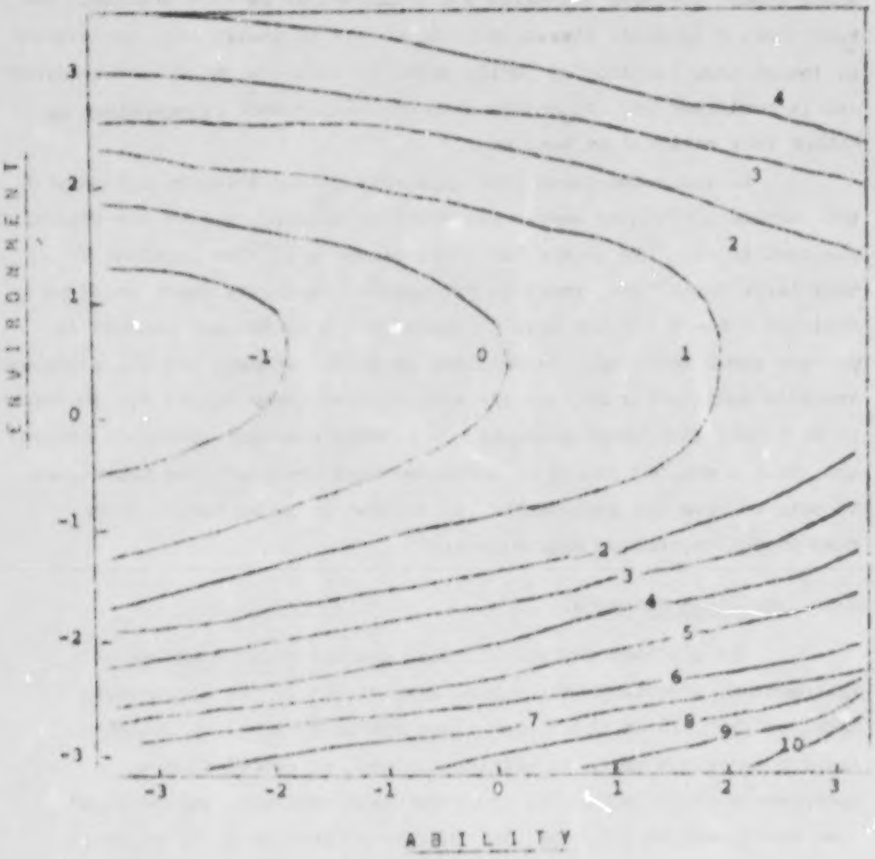
The findings reported in this chapter raise a number of interesting, important and complex issues. It is not appropriate, here, to list all of these, but there are some which, we believe, deserve immediate comment. First, although we experienced some successes with the canonical and regression analyses, and obtained some interpretable findings, our successes were not as great with the perception measures as those reported by Anderson and Walberg (1974). It was the case that in our canonical and regression analyses we were more successful in predicting the class environment than individual success - a situation which parallels the Anderson and Walberg experiences - but we did not obtain a large number of significant increments. This could be taken to imply that the perception measures are not powerful measures for studying learning environments.

It is also appropriate to note that there were few significant associations between the behaviour categories and the outcomes. In fact, the number of significant associations between those measures and outcomes and between the perception measures and outcomes was not much better than would be expected by chance - hardly an ...

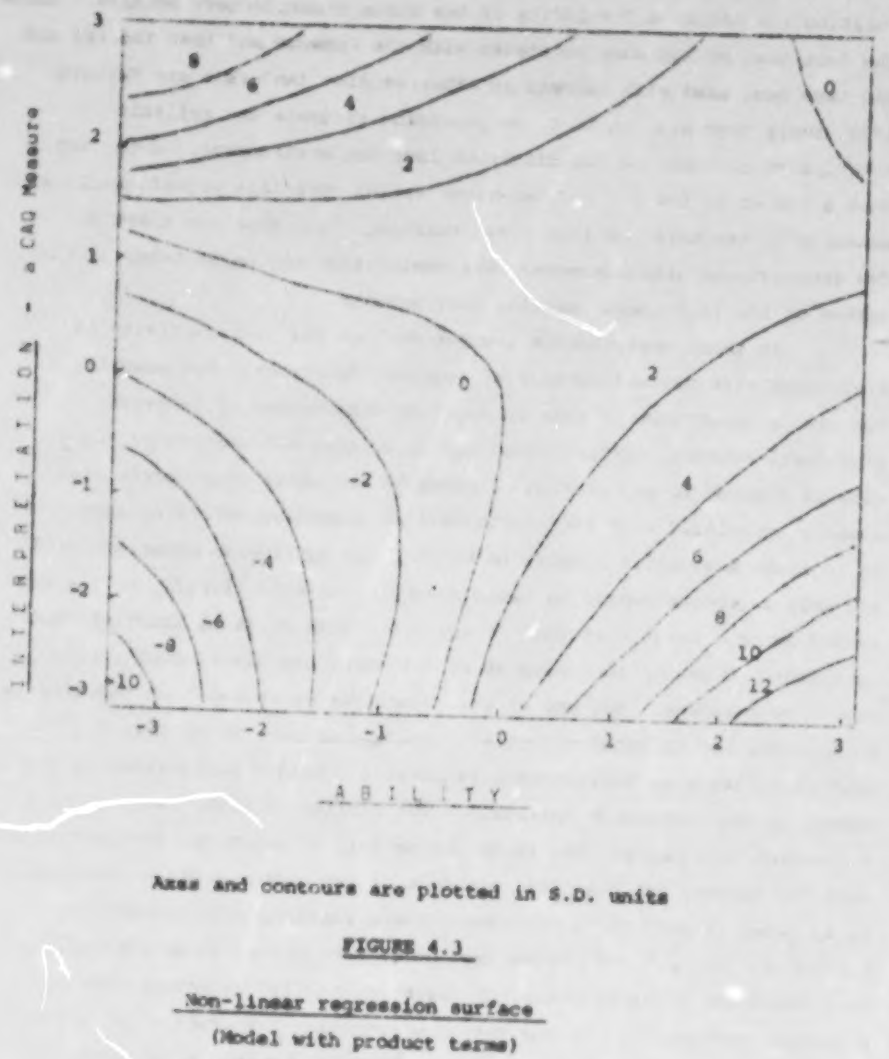
FIGURE 4.2 **Non-linear regression surface**

(Model with product terms)

Environment versus Ability (Achievement as Criterion)



(Note: Axes and contours in S.D. units)



Axes and contours are plotted in S.D. units

FIGURE 4.3

Non-linear regression surface

(Model with product terms)

Interpretation versus Ability

(Achievement as Criterion)

encouraging array of findings!

Our results are a curious mix, particularly with respect to the behaviour and perception measures. There were a number of interpretable and logically consistent congruencies between the behaviour and perception categories, but the few significant associations with outcomes call into question the nature and validity of the three classifactory schemes. However, the fact that we had some successes with the schemes and that the LEI and CAQ have been used with success in other studies (Anderson and Walberg, 1974) imply they may, in fact, be providing accurate and reliable descriptive pictures of the classroom learning environment. Note, too, that a number of the LEI and behaviour scales correlate significantly with measures of teachers' beliefs about teaching. Why then are there so few associations with outcomes? One explanation may be in terms of the nature of the self-paced learning environments.

In these environments a great deal of the overt activity is associated with the maintenance of learning functions. For example, a reasonable proportion of time is spent on discussions of progress, procedural matters, difficulties, and in writing and observing. Less time is devoted to explanation of concepts and other overt activities clearly associated with the development of cognitive understandings. An implicit assumption appears to be that the curriculum materials will not only introduce pupils to basic concepts but will clarify, revise and extend these. Given that this is the case, then it is no surprise that behaviour and perception measures do not correlate significantly with cognitive outcomes. But one of the objectives of research on teaching is to discover how to enhance pupils' cognitive gains. To do this for self-paced learning environments requires a detailed examination of the nature of the curriculum materials. The clarity of their language, the sequencing of concepts, the range and variety of examples, the provisions made for review, and the like, are some of the features which might well be included in such an examination. These features will, hopefully, distinguish the A.S.E.P. units from other more conventional curricula and text-books and be significant for fostering pupils' understandings. A content analysis may be one way of approaching the problem and already we have begun this type of procedure. Another way may be to study the teaching strategies embedded in the curriculum by using techniques like the Venture Analysis developed by Smith et.al. (1967)

Finally we would like to comment briefly on the educational significance of our findings. For the teacher wishing to maximise pupil achievement and satisfaction in self-paced and open settings, the data do indicate the need

(i) to create a sense of shared purpose and direction (e.g. by appropriate use of structuring c.f. Power and Tisher, 1975)

(ii) to insist that pupils do memorize and revise important facts and concepts, and

...

(iii) to play a very active role in working with pupils, counselling, informing and guiding individuals and groups but without dominating class discussion.

That the introduction of a new set of curriculum materials can have a profound effect on what happens in the classroom and leads to changes in how pupils perceive their learning environment does place a heavy responsibility on curriculum specialists, research workers and decision makers. For example, our data indicate that the decision makers need to obtain information about the value orientations and beliefs of those who will use a curriculum innovation. Certainly we found that many teachers did not hold values congruent with those of A.S.E.P. and that this lack of congruence did have undesirable consequences on the classroom. As such, our findings constitute a challenge to the particular model of curriculum development, dissemination and implementation adopted by A.S.E.P.

5. Experimental Study of Teachers' Structuring Behaviour.

5.1 Introductory Comments.

Whatever curriculum materials the science teacher has elected to use, he must manipulate the learning environment in which understandings (and sensitivity) can develop. His activities, including the comments he makes, to a large degree steer the activities of the pupils and, hopefully, focus their attention on certain goals, content and procedures. A number of the activities have been designated structuring moves by Bellack et.al. (1968) since they are pivotal points in classroom discourse and initiate, steer and terminate classroom activities. Other writers have also used the term. Rosenshine (1971) for example uses 'structuring' to refer to those comments, by the teacher, which occur at the beginning or the end of a lesson and serve as 'initiators' or 'terminators' of discussion. He uses the term as well to designate teachers' comments made before and after a question is asked.

The term 'structuring' implies that a major function of so-named moves is to provide a 'structure' or scaffolding for ideas and specifics to come, or for those which have just been presented. The concept of structure features prominently in the writings of many curriculum and learning theorists. For example, Ausubel (1968) uses the term 'organiser' to describe a class of structuring moves designed to present the 'relevant subsuming concepts' at a high level of generality. He argues strongly for the inclusion of such organisers, in introductory overviews to provide 'anchoring foci for the reception of new material'. In Ausubel's view, if the relevant subsuming concepts are not available in the learner's cognitive structure, acquisition is unlikely to be a meaningful process. Organizers presented beforehand are commonly called 'advance organizers' and those contained in structuring summaries after a presentation are called 'post organizers'. The latter are intended to consolidate and integrate previously established ideas.

In general, the research data indicate that advance organizers do facilitate learning from meaningful lesson material (Ausubel & Fitzgerald, 1961, 1962; Ausubel & Youssef, 1963; Fitzgerald & Ausubel, 1963). In most cases it has been found that the provision of advance organisers did improve learning and retention; however, in no case was the improvement very large. Studies using quantitative techniques developed by Anderson (1971) and Carss(1973) to analyse the structure of teacher-student interaction and curriculum materials, indicate that the overall structure and organisation of lessons and curriculum materials is important in science teaching. In studies of this type (Anderson, 1971; Butterworth, 1974; Browne & Anderson, 1975; Clarke, 1973, 1975) students who used more carefully integrated and organised materials or who experienced more structured lessons

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learnt more, and expressed greater satisfaction than students in less structured modes.

However, a careful inspection of the research data reveals that the relationship between structuring and achievement is not clear cut. In a re-analysis of the Bellack et.al.(1966) data, Furst (1967) found that the superior teachers only made moderate use of structuring, while other studies seem to indicate that the optimal level of structuring may depend on the properties of the pupil, the task, and the teacher. For instance, dependent-prone and culturally deprived pupils seem to prefer and learn more in structured situations, whereas independent, very able students and college males do not (Brophy & Evertson,1974; Grimes & Allinsmith, 1961; McKeachie, Lin and Mann, 1971). In a project using written materials, Bauman and Glass (1969) found that post-organisers were somewhat more effective than pre-organisers, although neither type was found to produce significantly superior achievement to that of a control group. In a detailed naturalistic study, Wright (1969) found that achievement gains were closely related to the extent to which teachers revise at the end of lessons. The use of terminal-information structuring to gather up loose ends, consolidate and integrate learning experiences at the end of a lesson (i.e. post-organisers) was more strongly associated with achievement than teachers' use of recapitulation at the beginning of the next lesson.

It would appear that for many pupils carefully organised and structured learning experiences and materials, advance and post-organisers are likely to facilitate the acquisition and retention of content. The somewhat traditional values implicit in Ausubel's position appeal to many science educators who find in Ausubel's writings a theoretical rationale for the notion that the chief responsibility of teachers and curriculum materials is to present an organized body of knowledge to pupils, and that of the pupil is to ingest it. But other theorists (e.g. Rogers, 1969; Suchman, 1960), curriculum workers (e.g. Samples, 1971) and teachers are concerned more with fostering self-actualization than with mastery of content, and they believe that highly structured curricula and teaching is dehumanising, gets in the way of pupil thinking and inhibits the development of inquiry skills.

This rift in value orientations became apparent to us in discussions held with ASEP staff and trial teachers in the early phases of our research project. Whereas some ASEP staff believed in and produced highly structured units, others argued for and developed units which provided pupils with relatively little explicit guidance as to how to tackle problems. Furthermore, in some of the more open-ended ASEP units, teachers were requested not to advise pupils how to plan their work, but merely to introduce problems and explain to pupils what was required of them. Trial teachers also expressed concern about how much

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structure they should provide in their lessons, compared to fostering inquiry. Now, problem solving and inquiry involves the generation and exploration of alternative hypotheses. At least some of this exploration can be undertaken by the learner himself. Yet in many situations it is neither efficient nor desirable to allow the learner to explore all possible alternatives. Accordingly some structure, some guidance, which draws the learner's attention to underlying principles, and rules and/or which clarifies and consolidates these, needs to be provided by the teacher. The critical question becomes: "How much should be provided within the materials, by the teacher, and at what points in the learning sequence?"

5.2 The Previous and Present Experimental Phase.

In our first study (Tisher & Power, 1973) we were concerned with the question of how much structure was needed to facilitate achievement and satisfaction within the unit "Light Forms Images". The data indicated that a moderate amount of teacher structuring, especially by persons whose educational values were not completely congruent with the ASEP approach, did facilitate learning. On the other hand, pupils of teachers whose values were more open and more congruent with those of ASEP performed less well on criterion-referenced tests if the teacher diverged considerably from the printed curriculum guide.

With respect to changes in pupil attitudes, pupils appreciated additional structuring by the teacher when the teacher's values were more congruent with those of ASEP (i.e. open, pupil centred, inquiry oriented). On the other hand, pupils taught by Diplomates with a more traditional orientation toward teaching enjoyed the unstructured situation more than the structured ones. Consequently, it appeard that a balancing mechanism was operating, counteracting the effects of extreme positions.

In this project we extended our examination of structuring but we were more concerned with the effects of variations in the temporal locus of teacher structuring than in variations in the amount of structure.

The methodology adopted in this phase of the study has already been described in a previous chapter where the treatments were also described (c.f. chapter 2). The particular pre-test measures which were used as co-variates were:

1. Inter D Scholastic Aptitude
2. Understanding of ecological concepts.
3. Understanding of population ecology.
4. Attitudes towards pollution issues.
5. Attitudes towards population control.
6. Attitudes towards resource utilization.
7. Interest in science lessons,

...

while the post test measures included:

8. Understanding of ecological concepts (Ach 1)
9. Understanding of population ecology (Ach 2)
10. Attitudes towards pollution issues (Attit 1)
11. Attitudes towards population control (Attit 2)
12. Attitudes towards resource utilisation (Attit 3)
13. Interest in ASEP Science lessons (Satis 1)
14. Perceived amount of learning (Satis 2)
15. Satisfaction with organisational content (Satis 3)

Pupils' perceptions of the ASEP learning environment (as measures by LEI) were used as dependent measures.

5.3 Effects of structuring on pupil perceptions.

A 3 (teacher values) x 4 (treatment) multivariate analysis of variance with the 15 Learning Environment Inventory scales as the dependent variables was used to examine the effects of the experimental structuring treatments, teacher values, and their interaction on the social climate of learning. A multivariate analysis is useful in problems such as this one as it provides not only tests for the contribution of each effect to each dependent variable separately, but also tests of overall concomitant effects on all variables considered simultaneously. Indeed, a multivariate test is essential to avoid the fallacy of obtaining statistical significance among correlated dependent variables through repeated application of a univariate test. Multivariate F utilizes the entire within-group matrix of variances and co-variances of the measures. A similar matrix is computed between groups for the interaction, eliminating all preceding effects. These matrices are compared to determine if between group differences are large, relative to random within group variation.

Teacher values were entered in the design first in order to provide the most conservative test possible for the experimental effect. By entering values first, the variance related to this factor was removed for the 15 dependent variables prior to examining the relationship of the treatments to the learning environment variance. The multivariate analysis first performs an F-test for equality of mean vectors for each main effect and interaction in the design. The overall results of the significance tests are summarized in Table 5.1 All three effects were statistically significant. In effect, the results tell us that each mean can be explained only as a function unique to the particular group. That is, the best prediction of the mean for a group is the observed value itself. In the presence of a significant interaction effect, we have no valid test of the main effects. To interpret this finding we may inspect the univariate F statistics presented in Table 5.2.

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The univariate statistics indicate that the interaction effect applies largely to formality, environment, friction and disorganization. The estimated means (combined across sub-classes) and treatment by values interaction are presented in Tables 5.3 and Figures 5.1 and 5.2. The data indicate that the interaction is ordinal, and that, despite the presence of a significant interaction effect, the main effects reveal a consistent trend for many dependent variables.

In particular, it would seem that pupils allocated to the ASEP-only-treatment see their classroom as more disorganised, having more apathetic pupils and more friction, but less formality and a less rich environment than those allocated to the structuring groups. The post structuring group stands out, with these pupils seeing their classes quite differently from the unstructured group, while the pre and mid structuring are intermediate. Being assigned to a class taught by an ASEP dissonant teacher led pupils to see the class as being characterised by less disorganisation, apathy and friction but more formality and a better physical environment than class assigned to mixed or ASEP congruent Dip. Ed. students (the latter being virtually indistinguishable). The foregoing interpretation was confirmed by a series of multiple discriminant analyses undertaken to determine combinations of variables which maximally discriminate among the groups.

Whereas the presence of a statistically significant interaction effect does cloud the picture somewhat, this effect appears largely as a slight embellishment to what are educationally (and statistically) stronger treatment and value effects. The data clearly indicate that in the absence of additional structuring by the teacher, pupils perceive the classroom in far less favourable terms, especially in relation to the amount of friction and disorganization in the classroom. In improving students' perception, post structuring appears especially useful.

TABLE 5.1 Summary of MANOVA results for Values x Treatments design with LEI scales as dependent variables.

Source of Variation	Degrees of Freedom	Multivariate F F ratio (df)	Probability
Constant	1	-	-
Values, eliminating constant	2	2.98(30,210)	.0001
Treatments, eliminating constant & values	3	4.59(45,312)	.0001
Interaction, eliminating all the above	6	1.66(90,597)	.001
Among means	12		
Within groups	119		

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TABLE 5.2: Summary of ANOVA results for Values x Treatments design with LEI scales as dependent variables.

Scale	F - ratio		
	Values^a (2/119)	Treatments (3/119)	Interaction (6/119)
Cohesiveness	1.52	2.97*	.60
Diversity	3.01	.76	.51
Formality	3.50*	5.15*	3.51*
Speed	3.98*	3.04*	.81
Environment	7.89**	10.96**	4.13**
Friction	19.35**	25.33**	4.03**
Goal direction	3.03	9.42**	2.05
Favouritism	3.47*	10.35**	1.40
Cliqueness	6.30**	6.94**	.58
Satisfaction	2.88	9.12**	.43
Disorganization	7.78**	12.76**	3.24**
Difficulty	.52	1.76	1.09
Apathy	5.46**	6.03**	2.59*
Democratic	4.09*	.38	2.05
Competitive	2.32	.77	.72

* $p < 0.05$

** $p < 0.01$

a: degrees of freedom shown in brackets

TABLE 5.3: **Estimated means for groups on LEI scales for which significant interaction effect exists.**

Group	n	LEI Scale				
		Formality	Environ.	Friction	Disorg.	Apathy
Values						
1. Dissonant	48	17.1	15.7	14.8	13.1	12.7
2. Mixed	42	16.4	13.6	17.5	14.6	14.1
3. Congruent	41	16.1	14.1	17.5	15.1	14.1
Treatments						
1. ASEP	36	15.7	13.7	19.0	15.6	14.6
2. Pre	30	16.5	14.5	16.6	14.3	13.7
3. Mid	33	16.5	14.5	16.6	14.3	13.7
4. Post	31	17.3	15.2	14.3	12.9	12.8
Cells						
1,1	12	16.3	14.9	17.2	14.4	13.6
1,2	10	17.1	15.7	14.8	13.1	12.8
1,3	13	17.1	15.7	14.8	13.1	12.8
1,4	13	17.9	16.4	12.5	11.7	11.8
2,1	12	15.6	12.8	19.9	16.0	15.0
2,2	10	16.4	13.6	17.5	14.6	14.2
2,3	10	17.3	14.4	15.2	13.3	13.2
2,4	10	17.3	14.4	15.2	13.3	13.2
3,1	12	15.3	13.3	19.8	16.5	15.1
3,2	10	16.1	14.1	17.5	15.1	14.2
3,3	10	16.1	14.1	17.5	15.1	14.2
3,4	9	16.9	14.9	15.2	13.8	13.3
Overall mean	131	16.5	14.5	16.6	14.3	13.7
Pooled within group S.D.		2.0	2.7	2.6	2.7	2.5

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FIGURE 5.1: TREATMENT BY VALUES INTERACTION FOR FRICTION

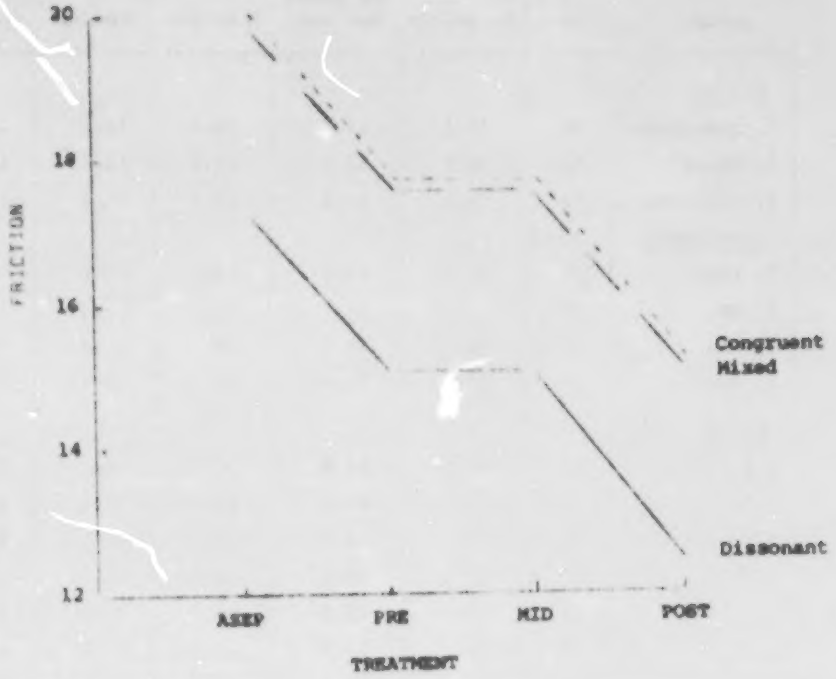
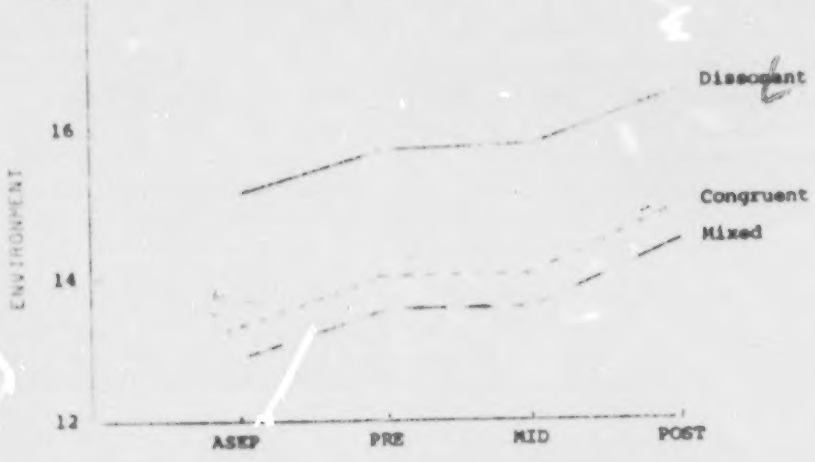


FIGURE 5.2: TREATMENT BY VALUES INTERACTION FOR ENVIRONMENT



5.4 Effects of structuring on achievement, attitudes and satisfaction.

The data were analysed using multivariate analysis of variance with the set of 7 pre-tests described earlier as covariates and the set of 8 post-tests as the criteria. Values and Treatments were assumed to be fixed effects. A summary analysis table is presented in Table 5.4

Data analysis revealed a significant interaction effect. In this analysis, the dependent variables were arranged in a logical order - achievement, attitudes, satisfaction. Examining the stepdown results, we find that the interaction effect stems largely from variable 13 and, to a lesser extent, to variable 14, eliminating achievement and attitude effects. Univariate analyses of varience (shown in Table 5.5) confirm that the adjusted criterion variables most affected by variations among treatment-value cells were variables 13 and 14, which measured pupils' interest in the ASEP lessons they experienced and their perception of the amount they learned, relative to other science lessons.

Referring to the estimated means (Table 5.6) for interest in ASEP lessons (Figure 5.3) we see that, in general, pupils in the experimental groups experiencing some additional structuring by film and teachers (pre, mid and post) expressed a higher level of interest and satisfaction, particularly groups experiencing post structuring. The trend in the data for perceived amount of learning followed the same pattern.

Eliminating the interaction effects, the main effect for treatments was found to be significant ($p < .001$). Estimates of the effects for variables 13 and 14 reveal a clear trend : post-structuring > pre-structuring > midstructuring > ASEP materials. Contrasts revealed that post-structuring was superior to pre-structuring, supporting the Bauman and Glass and the Wright results. Univariate analyses revealed a significant main effect for variables 13 and 14 only, and the same general trends. While multivariate F revealed no significant main effects for values, one univariate F (variable 14) approached significance. The data imply that classes taught by ASEP-congruent teachers are more satisfied, but the lack of significant differences suggests this effect is at best small. It is interesting to note that whereas the treatment and the interaction effects were significant, the effects were largely on pupil interest and perception of learning. The treatments and the general educational values of teachers did not appear to affect measured pupil-learning or pupil-attitudes towards ecological issues.

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TABLE 5.4 SUMMARY OF MANOVA RESULTS FOR VALUES X TREATMENT DESIGN WITH PRE-TESTS AS COVARIATES AND POST-TEST AS CRITERIA

Source	df	Multivariate F		Stepdown F	
		F	df	y13/y8-12	y14/y8-13
Constant (M)	1	-	-	-	-
Covariates (X)	6	9.35***	56,570	-	-
Values (A) elim. M,X	2	1.13	16,210	-	-
Treatments (B) elim.M,X,A	3	2.23**	24,305	9.86***	1.94
Interaction elim. M,X,A,B.	6	1.76**	48,521	5.76***	2.10*
Within groups	112				

* p < .05
** p < .001
*** p < .0001

TABLE 5.5 SUMMARY OF ANOVA RESULTS FOR VALUES X TREATMENTS DESIGN WITH POST-TEST MEASURES AS DEPENDENT VARIABLES, PRE-TEST AS COVARIATES

Post-test measure	F ratio		
	Values (2,112)[a]	Treatments (3,112)	Interaction (6,112)
Acht 1	1.51	1.42	.94
Acht 2	.59	.52	.65
Attit 1	.24	1.30	1.02
Attit 2	2.37	1.01	1.68
Attit 3	.08	.80	1.31
Satisf 1	2.78	12.03***	5.63***
Satisf 2	3.01	3.83 *	6.75***
Satisf 3	2.21	1.40	1.89

* p < .05
*** p < .0001

FIGURE 5.3: TREATMENTS x VALUES INTERACTION, EST. MEANS AFTER COVARIANCE ADJUSTMENT ON STUDENT INTEREST IN ASEP LESSONS

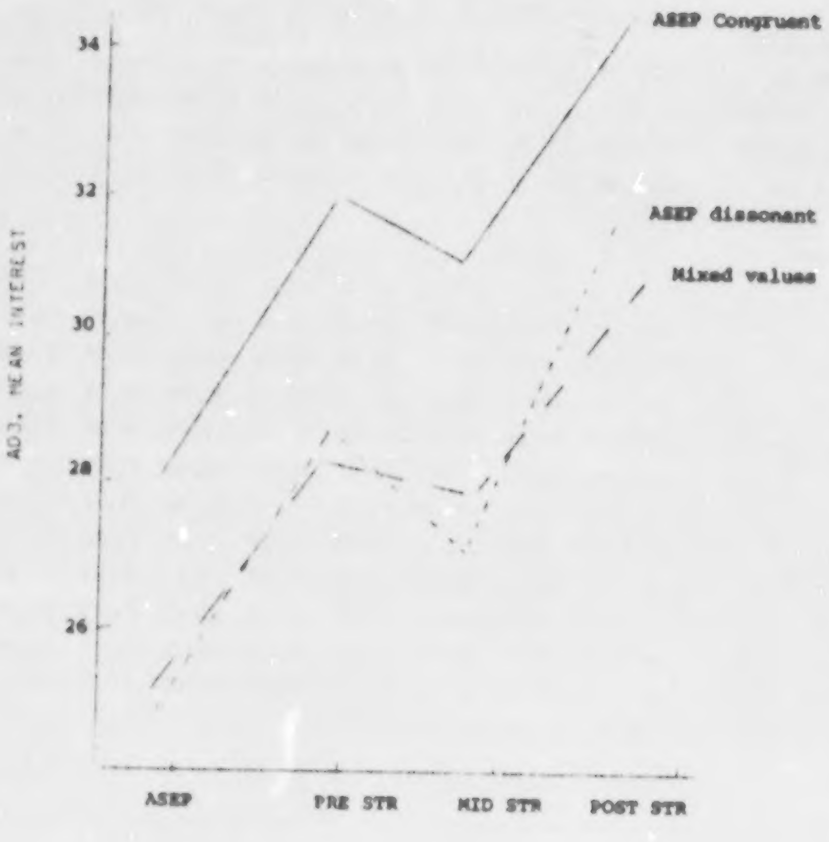

TABLE 5.6: ESTIMATED MEANS FOR POST TESTS AFTER COVARIANCE ADJUSTMENT

Group	N	Acht 1	Acht 2	Attit 1	Attit 2	Attit 3	Satisf 1	Satisf 2	Satisf 3
VALUES									
Dissonant (1)	48	8.22	10.49	23.70	23.74	22.63	28.50	21.26	16.62
Mixed (2)	42	8.02	10.68	23.66	22.95	23.43	28.19	21.72	16.53
Congruent (3)	41	8.04	10.00	24.18	23.37	23.31	31.62	23.78	17.58
TREATMENTS									
ASEP (1)	36	8.30	10.37	22.82	28.59	22.00	26.11	20.85	15.76
Pre Str (2)	30	8.31	10.69	24.33	24.06	23.76	29.96	22.25	17.08
Mid Str (3)	33	8.23	10.50	23.60	23.62	23.34	29.06	20.27	17.31
Post Str (4)	32	7.74	10.00	24.53	23.63	23.40	32.61	23.65	17.92
CELLS									
1,1	12	8.41	10.31	22.51	22.63	21.48	25.21	19.34	15.26
1,2	10	8.46	11.24	24.73	25.10	23.81	29.13	21.71	17.30
1,3	13	8.12	10.30	23.30	23.65	22.26	27.72	21.29	16.82
1,4	13	7.91	10.06	24.24	23.56	22.97	31.96	22.72	17.07
2,1	12	8.04	10.56	22.62	21.66	22.36	24.98	20.26	15.36
2,2	10	8.41	11.32	24.35	24.21	24.36	28.66	21.62	17.01
2,3	10	8.31	10.92	23.41	22.96	23.77	28.06	21.74	17.15
2,4	10	7.31	9.93	24.26	22.95	23.22	31.04	23.26	16.59
3,1	12	7.66	10.19	23.42	21.97	22.15	28.15	22.96	17.15
3,2	10	8.07	9.51	23.92	22.87	23.11	32.10	23.82	17.82
3,3	10	8.26	10.29	24.09	24.25	23.98	31.39	23.77	17.96
3,4	9	7.99	10.02	25.08	24.37	24.01	34.85	24.97	18.59
Mean	131	8.39	10.89	23.94	23.85	23.60	29.44	22.25	17.34

5.5 Concluding Comments

The preceding interpretations were made on a set of results derived from classes who were being exposed briefly, and for the first time, to ASEP materials and the associated manner of dealing with these materials. The effects obtained may or may not persist over time. Furthermore, the extent to which the interaction effects are generalisable is also open to question, especially as the sample was small and the teachers had no previous experience with ASEP, and for that matter little experience in handling classes of pupils.

With these qualifying conditions in mind, we will be bold (or tempted?) and suggest that in the initial stages of using ASEP materials the teacher needs to take time, towards the end of the unit, to assist pupils to integrate and consolidate the learning experiences they have had.

In self-paced programmes like ASEP and for that matter ISCS, the teacher is expected to create a vital, viable learning environment in which he manages the situation but does not dominate in the cognitive learning activities. He is not expected to play the role of an announcer or lecturer in a broadcasting station, but that of a person who stimulates interest and meaningful learning activities and who devises ways of integrating diverse individual experiences so that clear, stable, usable concepts and generalisations will be established in learners. He may be likened to the conductor of an orchestra, and as such, he is responsible for the subtle blending of notes from many instruments to produce a work of art rather than a cacophony. In producing the work of art he must give structure, meaning and purpose to the activities, but yet be sufficiently flexible for individual talents to emerge.

6. "PENELOPE'S WEB"

In one sense the title of this concluding chapter is an apposite one, for there is still a great deal to be done in research on learning environments and learning strategies. In fact, research on the teaching-learning process appears to be a never-ending task. However, the task is not as unproductive as the one undertaken by Penelope, the wife of Ulysses in Greek mythology. During her husband's long absence she, nightly, unravelled the web she had woven during the day so that she would not have to choose from among the waiting suitors. In this project we have been able to complement the work of other researchers and so add to, rather than destroy, our understanding of learning environments. We have experienced a number of successes which have resulted in new insights into the nature of the learning environments where self-paced curriculum materials are used. For example, we have specified the differential effects of pre and post-structuring, the range and variety of activities in lessons, the changes in pupils' perceptions of their learning environments, and the differences made by the introduction of new curriculum materials. We have also noted the consistencies between our findings and those of other researchers. These details have been discussed fully in preceding sections of this report and will not be repeated here. The objectives of this chapter are few and specific. Our aims are to refer to several unanswered questions which could profitably provide a focus in other studies, to comment on some of the methods used in research on teaching and, as a direct consequence of that discussion and our experiences studying learning environments, to propose other approaches which should be incorporated into new research projects. For convenience the ensuing discussion is grouped into sections which, however,are not mutually exclusive.

5.1 Some Unanswered Questions

In this present project and in our previous one (Tisher and Power, 1973; 1975) we observed a high proportion of classroom activities which had as their functions fact-stating and the discussion of purposes, procedures, difficulties and progress. There was also a proportion of activities classified as irrelevant to the learning task. Despite this and the fact that there was not an extremely high proportion of activities classified as interpretation, explanation and the like (i.e. higher cognitive), pupils made cognitive gains. In fact, they were expected to make these gains. Prima facia it appears that the curriculum materials (i.e. the ASEP units) were playing a major role in developing pupils' understandings. However, we did not study the nature of the materials, and their impact on pupils' understandings in science. In particular, we did not examine what pedagogical strategies were incorporated into the materials to enhance pupil learning. We believe that the nature and impact of different forms of curriculum materials must be studied more extensively if we are to understand the impact ....

of self-paced learning environments on pupils. Content and thematic analyses are not the only approaches; an examination of pedagogical strategies may also be useful. We have suggested elsewhere in this report that the ideas in Venture Analysis (Smith et.al, 1967) might be an appropriate starting point.

Our analyses of classroom activities concentrated on the frequency of behaviours and their functions. In common with many other researchers we did not examine the nature and effect of different patterns and sequences of activities. Initially we wanted to discover, as quickly as possible, as much as possible about the nature of self-paced learning environments in Australian schools. Now that we have this information we believe that more detailed studies of the sequences of activities can be undertaken. We anticipate that it will be possible to identify different patterns or sequences of activities in various learning environments and to use these different patterns to distinguish between the environments and the impact they are having on pupils.

But, to concentrate exclusively on curriculum materials and sequences of activities will, in our view, result in a neglect of other essential features of the learning environment. As we have argued in this report the perceptions which pupils and teachers have of the learning environment constitutes important information for the research worker. In this study we obtained data on perceptions by using the Learning Environment Inventory and the Class Activities Questionnaire. Only a modest attempt was made to gain a wide range of information through open-ended responses, and, consequently we do not know what was the full range of pupils' perceptions of the learning environment. Also, we did not know what "definitions" they had of the learning situation, nor if their "definition" was congruent or not with that of the teacher. Now the definition of a..

> ....."situation is a synthesis, interpretation, and inter-relation of the salient predispositions, intentions, and elements of the setting" (Stebbins, 1970)

When there are differences (between teachers and pupils) in definitions, there will be, too, differences between the interpretations of classroom activities and, for example, what constitutes irrelevant or deviant behaviour. Stebbins (1970) argues that we need to obtain information on the definitions pupils and teachers have of learning situations, for the concept of the definition of the situation offers a powerful tool for coping with the enigma of the meaning of situated events.

6.2 Use of Non-Linear Models and MANOVA

There have been a number of worthwhile changes in educational research strategies over the years, but it is salutory to note the predominant role played by linear models. Recently several research workers and writers (e.g. Brown, 1975; Marjoribanks, 1975) have questioned the practice. Brown (1975) argues that at least six substantial problems have arisen through the application of the linear model which generally has the form

....

$$y = a + b_1 x_1 + b_2 x_2 + \ldots .+ b_n \ x_n + E$$

where y is a dependent variable, x_i are independent variables, k_i their associated weights, a is a constant and E an error term. One of these is that in its present applications in education the linear models are usually static.

> "That is, possible time delays in the effects of one variable upon another are very seldom acknowledged. While such delays may be implicit in the conceptual framework presented, they are almost never explicitly found in the method of analysis. It would seem that a dynamic view of educational processes ... might be more appropriate. For example, when it is stated that a person's achievement influences his or her study effort, then where x is a measure of previous achievement and y is a measure of present study effort, the hypothesised relation might be specified as
>
> $y\ (t + 1) = a + b\ x\ (t).$ " (Brown, 1975)

Also, educational researchers frequently add as many independent variables to the right hand side of the equation as possible, ignoring any rule for parsimonious modelling which suggests that the number of variables be kept to a minimum. Furthermore, there is a great deal of bewilderment concerning statistical significance. Brown (1975) states

> "The cardinal issue is the confusion of statistical significance with theoretical or even practical importance."

He argues for the addition of a number of other analytic techniques and models, including non-linear and non-additive relations among variables, to the repertoire of the educational researcher.

> ...."because the educational field must address a vast array of problems, it seems reasonable to argue that out theoretical and methodological tools used be correspondingly broad. Surely educational research should be more comparable to the diverse research in engineering rather than the more focused research in psychology. The danger of a highly uniform set of methods is sterility which precludes crucial problem solving due to the tightness of the imposition of the linear model"
>
> (Brown, 1975)

We have used models containing non-linear terms with some success in this study but, clearly, much more must still be done. Hopefully, other research workers will take up Brown's challenge, not to jettison the linear model, but to vary it by entering non-linear and possibly non-additive relations among variables into the equation.

> "Common forms of non-linear relations involve power curves, hyperbolic curves, and exponential/logarithimic relations. The choice of one of these classes and then a specific function is a genuine challenge to the researcher" (Brown, 1975).

....

Brown (1975) also suggests that MANOVA be used, as we have done in this project. MANOVA (and for that matter multivariate regression and even path analysis) has the advantage of giving a more complete picture of a total situation involving a number of independent and dependent variables. However, it is not yet encountered often in educational research but in those situations where it has been applied it has been found to be an extremely powerful analytic tool. Its use has also generated some criticism and controversey (c.f. Ahlgren, 1975; Randhawa, 1975; Randhawa & Michayluk, 1975).

Recently Randhawa and Michayluk (1975) applied MANOVA in their study of rural and urban learning environments and their findings complement those reported here. They included 46 grade 8 classrooms in their sample of 96. The remaining 50 were grade 11 classrooms. They found that course content does not effect the learning environment of the classroom generally (non-significant multivariate main effect) but (from ANOVA results) that course content effects only the cohesiveness (measured by the LEI) of the classroom significantly. Now the LEI measures which were significant in our MANOVA and subsequent ANOVA were formality, environment, friction and disorganisation. It is interesting to note that in the Randhawa and Michayluk (1975) study the rural classrooms were characterised by cohesiveness, cliqueness, disorganisation and competitiveness. Whereas, urban classrooms were characterised by environment, difficulty and satisfaction. The grade 8 classrooms, as compared with grade 11, were characterised by formality, friction, favouritism and cliqueness.

The successes experienced by Randhawa & Michayluk (1975) and by us in this project will, we hope, encourage others to use MANOVA to gain a more complete picture of total learning situations.

6.3 "New" Research Genres: Ethnographic Approaches

The discussion in the preceding sections contains another implication, namely that new research genres must be applied in studies of learning environments. This is a fashionable theme in the educational literature and a number of writers have developed it while questioning the approaches used in classroom research (c.f. Brown, 1975; Mitra, 1974; Robinson, 1974; Start, 1975). Robinson (1974) for example, criticises the fact that research in classrooms has tended to be within a psychometric paradigm

> ..."that is, the data of interaction, whether this be teacher talk, gesture or movement, or more rarely pupil talk, gesture or movement, are taken as fundamentally non-problematically open to measurement by existing instruments." (p.252)

He believes the pre-existence of coding categories (and presumably questionnaires such as learning environment inventories) result in closure rather than openness to the field under study. Consequently this type of research is in danger of committing the "mechanistic fallacy" that is,

....

> ..."of ignoring man's subjectivity, of creating an artificial framework of action which is neither related to man's intent nor gives any indication of the gap between researcher and researcher's accounts". (p.253)

He argues for alternative approaches to the study of classrooms "which are labelled micro-ethnographic, anthropological, sociographic and ethnographic" (p.254). The techniques employed in these last mentioned approaches are not "new" - they include comparative analysis of data, participant observation, case studies, interviews and other non-quantitative methods such as historical and legal analysis. They are, however, relatively "new" techniques in classroom research. Note, too, that Robinson (1974) does not advocate a complete rejection of quantitative methods but an extension of the approaches used in classroom research and an alternative stance to theory. He states:

> ..."the common theme of ethnographic studies is the stance taken to theory. Rather than developing a priori theoretical statements for which empirical validation is sought in the 'real world', this approach adopts an appositional relationship to the world so that 'facts' are seen as the product of the interrelationship between the researcher and the researched...the research act needs to be seen as a system of negotiation between the researcher and the subject". (p.254)

Furthermore, research accounts are the product of the interrelationship between researcher and researched, and it is imperative that these accounts make explicit the interpretative framework the researcher holds when he enters the research situation.

Some classroom researchers have begun to adopt ethnographic approaches and to report on their interpretive framework. One readily accessible account is that of Keddie (1971) who examined "two aspects of classroom knowledge: what knowledge teachers have of pupils, and what counts as knowledge to be made available and evaluated in the classroom". (p.133) Her techniques could well be added, or incorporated into studies such as those we have undertaken. Certainly it is our intention to do this in future projects.

It is appropriate, too, to note that the advocates of ethnographic approaches still value the study of language in the classroom. But language is seen not as

> ..."a common backdrop to interaction but as an integral part of the world to be explained. Language both structures the world and allows for the world to be structured. In using language a member is both acceding to his cultural setting and exercising some control over that setting. How the social structure of the classroom is produced, maintained and transformed through language becomes a central research problem."
>
> (Robinson, 1974. p. 258)

....

As we indicated earlier the preceding discussion was included because, as a direct consequence of our involvement in research on learning environments, we believe that a number of alternative approaches need to be used in studies of these environments to give greater understanding than that achieved by the 'psychometric paradigm'. There is a continuing challenge to understand the nature of the learning environment as it is to the pupils and teachers for whom these environments are a very pressing reality.

> "This understanding is not tapped by a questionnaire, elicited by an hour's interview, or captured on a sociometric chart, but may be reached through the persistent observation and shared analysis of the 'events' as they happen. This is not to say that the questionnaire, interview schedule or sociometric test have no uses; they have, but should be supplementary to observation. Observation is not a simple journey armed with the most sophisticated tape recorder, or even video-tape, into the back of the nation's classrooms..."
> ...." The challenge is ... to build up case studies of classrooms, ...where the analysis of language has been used to illustrate the embeddedness of language, the situational specificity of its meaning, and where the researcher's own self-analysis has illiminated the particular bias which his account has reflected."
> ...."Given the existence of such studies, it may be possible in the future to generate theoretical statements which have a wider application than to the study in which they were born".
>
> (Robinson, 1974. p.263)

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APPENDIX

Details of the Coding Scheme, and Criterion Tests

A. The SABIC Coding Manual.

B. Teaching Practice Questionnaire and Teacher Opinions Scale.

C. Pre and Post Criterion Tests and Item Statistics

D. Pre and Post Attitude Tests, and Item Statistics.

SABIC CODING MANUAL

A great many systems have been developed for classifying the behaviour of teachers and pupils in teacher-centred classrooms. In general, these systems appear to have limitations when one attempts to use them to describe the many and varied interactions between teacher, pupils and materials in inquiry-oriented, self-paced programs, such as the Australian Science Education Project. Indeed, the authors did attempt to use several of the existing schemes but found that none of these could be used in analysing interaction in A.S.E.P. classrooms without considerable modification. SABIC, a Scheme for Analysing Behaviour in Individualised Classrooms, grew out of these attempts.

SAMPLING BEHAVIOUR IN INDIVIDUALISED CLASSROOMS.

Persons who have observed both teacher-centred and self-paced classrooms cannot help but notice the much greater complexity of the latter. In the teacher-centred classroom, most of the time, the teacher is interacting with a target pupil or pupils while the rest of the class observes; in self-paced programs, twenty or more interactions among teacher, pupils and materials may occur simultaneously. The observer is faced with the "cocktail-party problem". On who and what should one focus in a room buzzing with activity.

In collecting a video record of A.S.E.P. classrooms, two videocameras, three microphones and a control console incorporating audio and video mixers were used. Of the three microphones, one, a radio microphone, was placed permanently on the teacher, and the other two on each of two groups of pupils. At the beginning of a recording, cameras followed the teacher and his microphone was turned up for the first three minutes. For the next three minutes, the focus was on one group, and for the next three, the focus was on another. Then back to the teacher for another three minutes during which time the remaining microphones were switched to another two groups. Subsequently, the behaviour of these groups was recorded, and so on.

UNIT OF ANALYSIS

Every ten seconds a beep was automatically recorded on the audio track. The basic unit of analysis in SABIC is the dominant behaviour observed during each ten second interval. A time rather than a functional unit was selected, because sampling the teacher and groups for three minute intervals precluded the possibility of a continuous behavioural record.

CODING SYSTEM

Interaction between persons is essentially a process of communication. One can identify the source of a message or act, the person transmitting, and the target of the message, the person(s) to whom the message or act is directed. A message or act can be of several types - questions may be asked and information given during verbal interaction; students may write, experiment, observe, etc. in working through curriculum activities. Acts may fulfil one or more functions, and may be designed to contribute to the intellectual processes of the classroom, instruction, non-instructional or affective processes. SABIC takes account of sources, targets, acts and functions. The details of the categories included in the system appear below.

1. SOURCE. The source of an act is the person or persons performing the act e.g. the person speaking, the persons observing, experimenting, etc. Under the column for source on the coding sheet (see sample which follows these details)

Code 1	if the source is Materials (e.g. when a film is being shown to a class, the film acts as the source of the messages being transmitted).
Code 2	if the source is the teacher (e.g. when the teacher is talking to a pupil or group, demonstrating etc.).
Code 3	if the source is the class (e.g. when all pupils in the class perform a common activity).
Code 4	if the source is a group of pupils (e.g. when between 2 and 6 pupils experiment).

..2

Code 5 if the source is a single pupil.

Code 0 if no source can be identified (e.g. there is no person in view).

(Note: 0, 1 and 3 are relatively rare).

2. TARGET. The target of an act is the person(s) to whom a message is directed or the materials on which an act is performed.

Code 1 when materials are the target.

Code 2 when Teacher is the target.

Code 3 when Class is the target.

Code 4 when a Group of pupils is the target.

Code 5 when a single pupil is the target.

Code 0 when an act has no target (rare).

3. ACT. An act identifies what the person(s) (or material) is doing during a ten second interval. The following acts are included in the classification scheme:

Code 1 when a primary question is asked i.e. any utterance which calls for a response. This includes not only grammatical questions (What is this?) and interrogation statements (Yes?) but also requests, directives and demands that call for a response (e.g. Someone tell him why the magnification is less.) A primary question is defined as a question which calls for a new or different response, that is, a response which would not be appropriate to the preceding question.

Code 2 when a follow-up question is asked, that is, questions in which the primary question is repeated or rephrased or in which the object is to probe a preceding response. The latter includes requests in which a student is asked to define terms in a response, to interpret the response, give facts to support the response, etc.

For example. T What about size? (primary question)
P They're microscopic. (response)
T What does that mean? (follow-up question)

Code 3 when a source is involved in information-giving. Information-giving is coded when discussion centres on the substantive topic of a lesson, e.g. facts about the products of combustion are given, data is interpreted, responses to substantive questions are given. Information-giving includes acts in which the statements made include propositions about the subject-matter of the lesson. These include the provision of information leading up to a question and those following a series of acts which are designed to consolidate or review previous activities or discussion.

Code 4 when directions are given. As well as discussing the subject matter of the lesson teachers and pupils discuss matters relating to the social-managerial functioning of the classroom, (e.g. which group is to do what), materials needed for activities, procedures to be used in combating difficulties, and so on.

Code 5 when the act performed is writing. In activity-centred classrooms such as A.S.E.P., students commonly record their observations and answer questions in workbooks. Writing is coded when this is the dominant activity observed in a 10 second interval.

Code 6 when students or the teacher are experimenting, that is, manipulating materials, specimens, etc. with the object of collecting data. In A.S.E.P. lessons, a group often acts as source, materials as the target and the dominant act is often experimenting. Often students also discuss the activity while experimenting, however, experimenting only is classified.

Code 7 when students or the teacher are observing others, e.g. when the teacher is watching a group of students at work.

..3

Code 8 when teacher or students are reading a text or other printed material.

Code 9 when a multiple act is observed in a ten second interval. For example, when the teacher asks a short question and a student gives information in response to that question.

Code 0 when no action is evident.

4. FUNCTIONS. For most acts, one (or perhaps two) functions can be detected. When a function is clearly evident it is coded in the appropriate columns. Code 0 when any particular type of function is not observed.

(a) INTELLECTUAL PROCESSES

Some acts involve or fulfil an intellectual function in the classroom - that is, some cognitive process is used in dealing with the subject matter under study.

Code 1 when the process is fact-stating, the giving of information which can be verified by empirical test and/or observation; to state laws, principles, generalisations.

Code 2 when the process used involves describing observed phenomena, giving an account of something that happened or representing a concrete object or event by words or drawing.

Code 3 when the process involves the interpretation of statements, data or terms. Included in this category are: definitions of terms (the giving of the defining characteristics or attributes of some set of objects, events or abstractions); paraphrasing statements or giving the verbal equivalent of a communication usually in order to make its meaning clear; extrapolations beyond mere description of data or observations where implications are examined and/or conclusions drawn.

Code 4 when the process involves explaining. To explain is to relate an object, event, action or state of affairs to some other object, event or state of affairs; to show the relation between an event or state of affairs and a principle or generalization; or to state the relationships between principles or generalizations; conditional inferring in which an antecedent and a consequence (e.g. cause-effect) are related, predictions.

Code 5 when some other cognitive process is used. For instance, evaluative statements which can be verified by reference to a set of criteria or principles of judgment, e.g. giving reasons for holding an opinion about population control; giving opinions about what is possible, what might obtain in the future.

(b) INSTRUCTIONAL PROCESSES

Some acts involve discussion of instructional rather than cognitive matters and/or the performance of acts in response to demands.

Code 1 when the purposes of an activity, the lesson, or the unit are being discussed. This includes discussion of the goals or objectives of the unit, the likely outcomes, the rationale for activities, etc.

Code 2 when the procedures to be used during the activity, experiment or in organizing groups and materials are discussed.

Code 3 when the difficulties encountered in an activity are being discussed. This includes discussion of modifications to procedures needed, content or instructions not understood etc.

Code 4 when progress towards the achievement of short or long term goals is discussed. The category includes comments indicating that work has or has not been satisfactorily completed, checks by teacher or other pupils on the phase reached in an activity and the like.

..4

Code 5 when students (or teacher) are following instructions relating to procedural matters. For instance, when students are organizing themselves into groups, collecting or returning equipment to storage cartons, wiping down benches.

(c) NON-INSTRUCTIONAL PROCESSES

Some activities serve neither a cognitive nor an instructional function; they contribute to neither the achievement of cognitive objectives not to the smooth running of the classroom. Categories included under this heading are:

Code 1 when the teacher or pupil(s) being observed on tape are ignoring attempts to involve them in the activities of a group. For instance, the teacher ignores a raised hand and continues to rest.

Code 2 when the teacher or pupil(s) is doing nothing e.g. daydreaming.

Code 3 when the activity engaged in is task-irrelevant e.g. horseplay, discussion of football results.

(d) AFFECTIVE PROCESSES

Some acts serve to communicate affective or emotional meanings. The "feeling tone" of an act is difficult to gauge because often such meanings are communicated by facial expressions (frowns, smiles, glares) gestures and verbal emphasis rather than by explicit statements of praise or blame. Despite the difficulties, the following codings are used when a clear expression of emotion can unambiguously be classified.

Code 1 when a positive emotional communication is addressed to another person, e.g. praise or encouragement or rewards are explicitely given.

Code 2 when a negative emotional communication is addressed to another person e.g. blame, explicit criticism, discipline.

Code 3 when a positive emotional meaning is expressed relating to the content being studied or the activity engaged in or a favourable position taken in relation to an issue arising out of content. For instance, when a position favouring population controls is taken in a unit on population ecology such as "How Many People".

Code 4 when a negative emotional meaning is expressed relating to the content being studied or the activity engaged. For instance, expressions of dislike or disinterest in an activity, rejection of attempts to improve the school environment flowing from ecological principles.

(e) OTHER

Code 1 when the function or process involved in an act cannot otherwise be classified.

SUMMARY : SABIC

CODING SCHEME

Source	1	Materials	Target	1M	Materials
	2	Teacher		2T	Teacher
	3	Class		3C	Class
	4	Group		4G	Group
	5	Pupil		5P	Pupil.
Act	1Q	question	Act	5W	writing
	2Q'	follow up question		6E	experimenting
	3I	information-giving		7O	observing
	4D	directions		8R	reading
				9	multiple act

..5

Functions

(a) Intellectual processes

1 FAC Fact-stating 2 DES describing

3 INT Interpreting 4 XPL explaining

5 COG other cognitive

(b) Instructional processes

1 PUR purposes 2 PRO procedures

3 DIF difficulties 4 PRG progress

5 following instructions

(c) Non-instructional processes

1 IGN ignores

2 NTH does nothing

3 IRR task irrelevant

(d) Affective processes

1 + Emotional - praise, encouragement.

2 - Emotional - sarcasm, discipline, criticism.

3 + Content - positive OR pro expression.

4 - Content - negative or anti expression.

(e) OTH other.

CODING PROCEDURE

1. Enter tape number, class, school and teacher on the top of the coding sheet and the code for that lesson in column provided.
2. Enter code for first ten second interval in column provided i.e. 001 and number intervals progressively, 002 upwards.
3. Play (and, if necessary, replay) tape for the first interval.
4. Identify the code source, target, act and function dominating that interval.
5. Replay until agreement among members of the team is teached.
6. Where more than one act occurs and neither is dominant, code the first act performed.

A SAMPLE

Coding normally is undertaken directly from a videotape. However, to illustrate use of SABIC a sample based on a lesson transcript follows:-

SAMPLE TAPE TRANSCRIPT AND CODING

TRANSCRIPT	INT	S	T	ACT	INT	INST	NON INS	EM	OTH
T: Which group has two magnets please? I've given out all the magnets, didn't you get one? (Teacher addresses class, hands magnet to one group).	001	2	3	1	0	3	0	0	0
T: Allright, now, what we want you to do is to make the piece of steel I've given you into a magnet. People with the horse-shoe magnet you only use one pole. You have to drag it along here.	002	2	3	4	0	2	0	0	0

Column heading over the coding columns: CODING SHEET WITH ENTRIES

..6

	INT	S	T	ACT	INT	INST	NON INS	EM	OTH
T: Right, now, test to see that the piece of steel isn't a magnet. Now how can you do that?	003	2	3	1	1	0	0	0	0
P's: Put it in the iron filings. T: Right. Put it in the iron filings.	004	4	2	9	1	0	0	0	0
T: Put one end in, lift it up and see. Allright, he might have some. Allright, turn the other end around, and go push it in. Lift it out.	005	2	3	4	0	2	0	0	0
T: You've been rubbing yours with the magnet haven't you? 14 No, sir.	006	2	5	9	0	2	0	0	0
T. Right, now, I want you to give it a rub, put your fingers along the piece of steel and give it	007	2	3	4	0	2	0	0	0
a rub, circularise, maybe 20 or 30 times this time. Do it now, go on. No, put it on the desk, Cheryl.	008	2	3	4	0	2	0	0	0
Group A performs activity(i.e. group observed)	009	4	1	6	0	0	0	0	0
Group A performs activity (i.e. group observed)	010	4	1	6	0	0	0	0	0
T: What are you two doing? (No.17 and 18) Come on.	011	2	4	1	0	0	3	2	0
T: Allright, that's enough now. Now try it in your iron filings.	012	2	3	1	0	2	0	0	0
Group C: Sir, we can't get the iron filings off. (Teacher helps students remove filings).	013	4	2	1	0	3	0	0	0
Group C: Pupils record results.	014	4	1	5	0	0	0	0	0
T: What did you notice about the number of iron filings? Group C: No more than before.	015	2	4	9	2	0	0	0	0
T: No more than before. Are you sure? P's: Yes, sir.	016	2	4	2	1	0	0	0	0
T: Class, hands up if you found that you had more than before? (1/2) Right, now, listen here.	017	2	3	4	2	0	0	0	0
T: Now, what do you think would happen if we take our magnet we made and cut it in half?	018	2	3	1	4	0	0	0	0
35: You'd have two magnets instead of one. T: Well, let's have a look at it.	019	5	2	3	1	0	0	0	0

..7

	INT	S	T	ACT	INT	INST	NON ING	EM	OTH
T: Now we said before - what do we know about the ends of the magnets? Judy?	020	2	3	1	1	0	0	0	0
34: They're stronger than the middle. T: That's the girl.	021	5	2	3	1	0	0	0	0
T: So now the second part, Anne, is going to be what? (No response)	022	2	5	1	4	0	0	0	0
T: Judy? 43: Weaker. T: Weaker, now, let's see what happens when we	023	2	5	9	4	0	0	0	0
T: put this centre part in when we've got our iron filings	024	2	3	4	0	0	0	0	0
T: So we try the other part of it. (Teacher demonstrates).	025	2	1	6	0	2	0	0	0
So we've got two magnets, in place of one. Now what have we covered the second time?	026	2	3	3	1	0	0	0	0
18: Not very much T: Not very much.	027	5	2	3	1	0	0	0	0
T: Right, so if we pass this around you can try cutting this yourself and see whether or not you can detect magnetism.	028	5	3	4	0	2	0	0	0
Group A experiments with sample magnet.	029	4	1	6	0	0	0	0	0
T: Taking one piece of your magnet, take one piece of it, and have you got something heavy around the place? P's: Yes.	030	2	4	4	0	2	0	0	0
T: And don't use the magnet. If you take this one, if we take Judy's and we see how many	031	2	4	4	0	2	0	0	0
T: iron filings we've got on it, now, we'll knock those off (teacher demonstrates).	032	2	4	6	0	2	0	0	0
T: Now, what's happened? P's: Sir, Sir.	033	2	4	1	2		0	0	0

'B'

TEACHING PRACTICE QUESTIONNAIRE

NAME: ______________________________ AGE: __________

SCHOOL: ______________________________ YEARS OF TEACHING: __________

JUNIOR SCIENCE CLASSES (Please specify ones taught this year) __________

____

JUNIOR SCIENCE COURSES USED (Please tick courses used here at school or elsewhere):

Q'LD.SCIENCE A, B ______ A.S.E.P. ______ J.S.S.P. ______

OTHER (Please specify): ______________________________

TEACHING QUALIFICATIONS: ______________________________

SCIENCE QUALIFICATIONS: ______________________________

This questionnaire is confidential and will be used for research purposes ONLY. Appearing on this page are ten sets of questions dealing with emphasis in classroom practices. In each set (e.g. 3.1, 3.2, 3.3) three practices are described. You are asked to state whether you give each practice: "a great deal of emphasis", "strong emphasis", "moderate emphasis", "slight emphasis", "little or no emphasis", in your own classroom teaching. Since no teacher could be expected to give equal emphasis to all three practices, please give high and low ratings to each emphasis as you honestly believe it applies to your own teaching of Junior science. Please try to answer each question. Answer each item by placing a checkmark in one of the spaces opposite that item.

ITEMS TEACHING PRACTICE	A GREAT DEAL OF EMPHASIS	STRONG EMPHASIS	MODERATE EMPHASIS	SLIGHT EMPHASIS	LITTLE OR NO EMPHASIS
1.1 Emphasis by teacher on subject matter of the lesson.					
1.2 Emphasis by teacher on personal relationships with and among pupils.					
1.3 Emphasis by teacher on disciplining and controlling pupils.					
2.1 Emphasis on communication from the teacher (e.g. lectures)					
2.2 Emphasis on communications between teacher and pupils (e.g. question and answer).					
2.3 Emphasis on free communications among all members (e.g. open discussions).					
3.1 Emphasis on the same activity for the class as a whole.					
3.2 Emphasis on the same activity carried out by different groups in the class.					
3.3 Emphasis on different activities carried out by different groups in class.					

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4.1	Emphasis on rules established by the teacher.					
4.2	Emphasis on rules established by agreement between teacher and pupils.					
4.3	Emphasis on rules established by pupils themselves.					
5.1	Emphasis on rules stating how pupils must behave.					
5.2	Emphasis on lack of rules for pupils behaviour.					
5.3	Emphasis on rules stating how pupils must not behave.					
6.1	Emphasis on effective use of rewards for pupil accomplishment.					
6.2	Emphasis on intrinsic pupil motivation (teacher avoids direct rewards or punishments for pupil behaviour).					
6.3	Emphasis on effective use of punishments for pupil inadequacies.					
7.1	Emphasis on a broad survey of the subject matter of science to acquaint students with the subject.					
7.2	Emphasis by teacher on developing a few ideas or topics in depth.					
7.3	Emphasis on a problem centred approach rather than on treatment of topics.					
8.1	Emphasis on teacher demonstrations.					
8.2	Emphasis on pupils using structured worksheets to guide laboratory activities.					
8.3	Emphasis on pupils devising and conducting their own experiments whenever possible.					
9.1	Emphasis on teacher as the major source of information about science.					
9.2	Emphasis on curriculum materials (test, films, etc.) as the major source of information.					
9.3	Emphasis on first-hand experience with phenomena as the major source of information.					
10.1	Emphasis on immediately reinforcing pupil answers 'right' or 'wrong'.					
10.2	Emphasis on encouraging pupils to decide when question has been answered satisfactorily.					
10,3	Emphasis on probing student answers to identify and clear up misconceptions.					

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TEACHER OPINIONS

This questionnaire has been designed to obtain opinions about the values which should underlie the production of a science course for Grades 8 - 10 such as the one A.S.E.P. is planning, and also to obtain some general impressions on matters related to the introduction of such a new science course.

Please answer the questions by ticking the appropriate box.

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNABLE TO ANSWER
1.	There is a fundamental core of scientific knowledge which all the students should know, and which should form the basis of the science course.					
2.	The science course should reflect the structure of the major scientific disciplines.					
3.	The major aim of the science course should be to develop attitudes such as commitment to enquiry, open-mindedness, intellectual honest.					
4.	As one of its major objectives, the science course should aim to contribute to the personal and social development of the child.					
5.	The science course should be based on student observation and experiment.					
6.	The structure of the science course should be based on the processes (reasoning skills) of science rather than content (factual knowledge).					
7.	The science course should place emphasis on science in its contemporary setting, especially the social implications of scientific knowledge.					
8.	The students should be allowed to work at their own rates.					
9.	A major aim of the science course should be to encourage the development of original ideas in the child.					
10.	A knowledge of the historical development of science should be a part of the science course.					
11.	Most of the work in the science class should be done in small groups.					
12.	The science course should allow for a variety of individual differences.					
13.	The findings of the behavioural sciences - psychology, sociology, anthropology - should form part of the junior secondary science course.					
14.	It is of great importance that the science course deals with the main theories of science.					

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	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNABLE TO ANSWER
15. An understanding of man's social and interpersonal relationships has a place in the science course.					
16. The development of such personal attributes as co-operation, persistence, tolerance and responsibility can be fostered by a suitable science curriculum.					
17. Knowledge which is most relevant to the everyday life of the students should be given preference in the course.					
18. Science should be taught as part of a general studies program rather than as a separate subject.					
19. As far as possible, the materials produced for students by ASEP should be 'teacher-proof' i.e. successful learning should be able to occur solely by interaction of students with materials.					
20. A significant proportion of ASEP funds will have to be spent on training teachers to use the materials produced if the Project is to be successful.					
21. The science course produced by ASEP should be separated into the major branches of science, e.g. chemistry, physics, biology, so that each of these major divisions of science may be studied separately if desired.					
22. Each child should possess a printed copy of all information to be learned.					
23. Open-ended investigations by students are possible, and desirable, from the very beginning of science education.					
24. Practical experience is not essential for the acquisition of scientific knowledge.					
25. A pupil may forget all he learned at school about facts and principles of science but the experience he gains in carrying out his own practical investigations will last him in good stead for ever.					
26. A teacher's time is better employed in giving lectures and demonstrations than in preparing for laboratory work.					
27. Pupils gain little of value from carrying out their own investigations.					

..12

PRE AND POST CRITERION TESTS

PRE-TEST : HOW MANY PEOPLE

This is a test of your knowledge and understanding of some ideas about science and our environment. Here are a few suggestions which will help you earn your best score.

1. Work carefully and at a steady pace.
2. Do not spend too much time on any one question.
3. If a question seems too hard, make the most intelligent attempt you can. You will make your best score if you attempt every question.

DIRECTIONS.

Each question apart from the first one is followed by 4 suggested answers. Choose the one you think is best and mark with a cross the letter on your answer sheet corresponding to this answer. An example is given below:

Example: Geology is the scientific study of -

A. the earth

B. plants

C. the human body

D. the stars.

You will see that the answer (A) has been marked by a cross (X) on the answer sheet.

Your answers should be marked on page two of the answer sheet in this way. The question paper should not be marked.

DO NOT TURN OVER UNTIL YOU HAVE ANSWERED THE QUESTION BELOW:

1. On the first page of the answer sheet write down in no more than half a page what you think are the most important things you have learned in your science classes this year.

Answer the following questions on the second page of the answer page.

2. The source of energy for all living things is

* A. sunlight

B. chlorophyll

C. plants

D. water

3. A group of living things of the same species, living in a definite space is known as

A. an environment

* B. a population

C. a sample

D. an ecological group

4. Ecology is the study of

A. the pollution occurring in the natural environment.

* B. living things in their natural environment.

C. samples in oceanic and fresh water environments.

D. the structure and function of nature.

..13

5. An estimate of the number of living things in a certain space is known as

A. sample

B. model

* C. census

D. population

6. The conversion of waste products back into the original resource is called

A. manufacturing

B. restoration

C. balance of nature

* D. recycling

7. A population of 2,000 mice was counted in a wheat field, 1/2 an acre in area. The density of this population was

A. 1000 mice/acre

B. 2000 mice/acre

* C. 4000 mice/acre

D. 8000 mice/acre

8. A species consists of individuals which

A. possess a similar body structure to one another.

B. possess a similar body colour to one another

C. produce young which are exactly the same as the parents.

* D. are able to interbreed

9. The owners of a match factory would most likely refer to wood, glue and phosphorus as

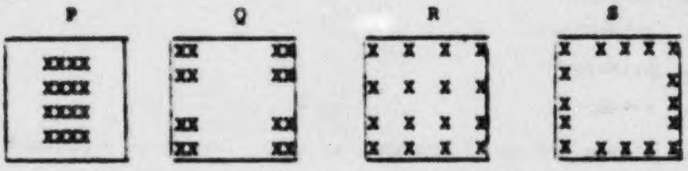
A. products

* B. resources

C. pollulants

D. wastes

10.



Each square represents a town with the locations of its factories shown. If all produce the same amount of waste products the town with the biggest pollution problem is

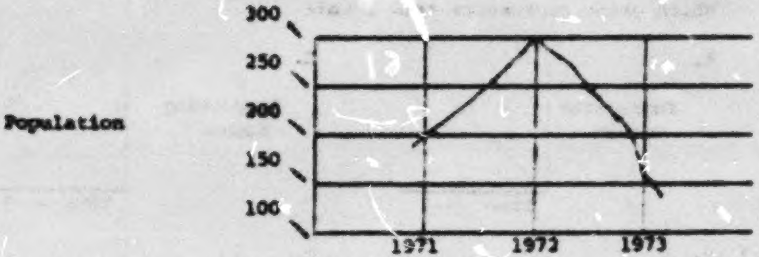
* A. P

B. Q

C. R

D. S

11.



The graph represents the population of a small town. What was the population change between 1971 and 1973.

A. +150

B. + 50

*. C. - 50

D. -150

12. Which of the following could have a serious effect on the everyday ecological cycles?

A. use of fertilizers

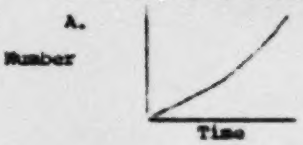
* B. chemical and industrial wastes in rivers

C. denitrifying bacteria

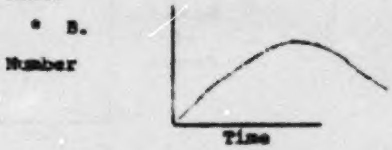
D. animal wastes and decay.

13. A growing population becomes limited by resources. Which of the following graphs represent this best?

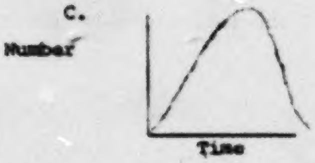
A.



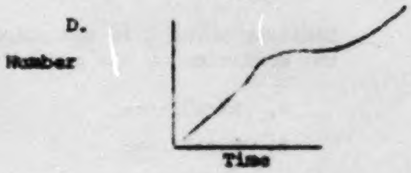
* B.



C.



D.



14. The most serious pollution problem would be likely to occur if the waste products (garbage and sewage) of

A. a small seaside town were allowed to flow untreated to the sea.

B. a small country town were allowed to flow into a river or lake.

C. a large city were allowed to flow into the sea.

* D. a large city were allowed to flow into a river or lake.

15. The population of a small island at the beginning of the year 1972 was 207 persons. During the year 24 babies were born but 2 died. 48 persons went to the mainland for their annual holidays but returned. There were 6 marriages and 13 deaths during the year and 8 persons left the island and do not intend to return. The size of the population at the end of 1972 had changed by

A. -47

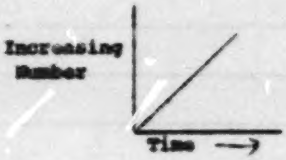
* B. + 1

C. - 1

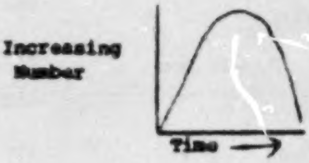
D. + 7

16. The population of a species increases and then becomes constant. Which graph represents this trend?

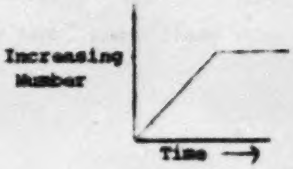
A.



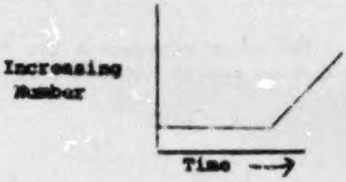
C.



* B.



D.



17. Man is using more and more oil producing heat and carbon dioxide. Bearing this in mind, which of the following is not true?

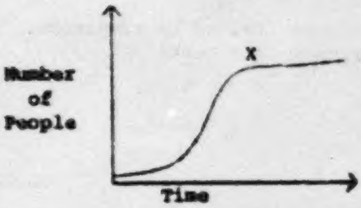
A. at the present rate of usage, all the oil will soon be used up.

* B. carbon dioxide is useful in that it can be recycled.

C. heat is a form of energy which is difficult to use again.

D. all the oil available to man is already on earth, no more can be made.

18.



Consider point X on the graph. Which of the following best describes the condition of the population?

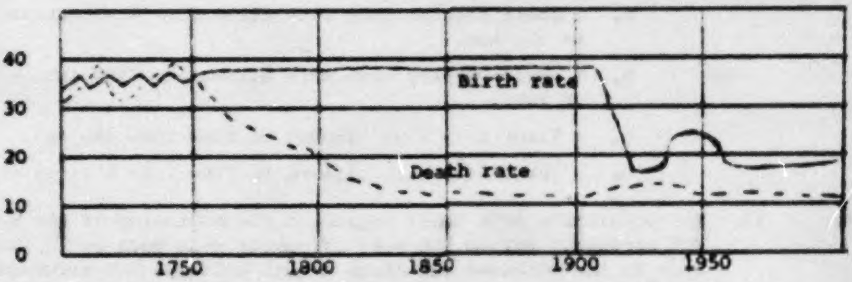
A. Birth rate = 0

B. Death rate = 0

* C. Birth rate = death rate

D. In-migration + out-migration = zero.

19.



According to the graph above the population increase was greatest in the period between

A. 1750 - 1800

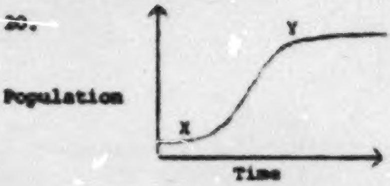
B. 1800 - 1850

* C. 1850 - 1900

D. 1900 - 1950

..16

20.



In a laboratory experiment, 0.5 ml samples of water were taken daily from a contriner in which there was a well fed paramecium population. The number of paramecium was counted in each sample and a population graph drawn up. What could cause the population to level off after Y?

A. the presence of disease organisims.

B. the presence of wastes and poisons.

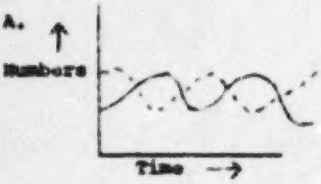
C. the amount of food and needed gases.

* D. each of A, B, and C above.

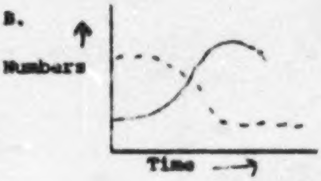
21. Which of the following graphs best represents the population changes over a period of three months when locusts invade an agricultural area?

———— Locusts ------------ crop

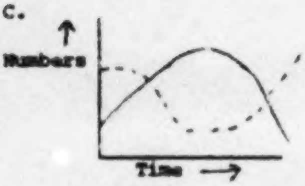
A.



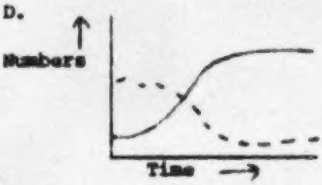
* B.



C.



D.



22. Even if there is enough food to sustain life, many biologists believe that there is a population crisis facing man. This belief is based mainly on the premise that there will soon be so many people that

A. there will not be enough solar energy to meet man's needs.

* B. the corresponding growth in technology would produce dangerous amounts of waste products.

C. there will be a major unemployment problem in many countries.

D. large scale wars would break out as nations compete for space.

23. Suppose we wanted to determine the level of interest about pollution in students in science classes in Queensland schools. The most accurate result would be obtained by questioning -

A. a sample of 20 classes from one large school.

* B. a sample of 20 classes from several schools.

C. all the classes in an average school.

D. the teachers of all classes in a large school.

ITEM STATISTICS FOR PRE-TEST

(Criterion Achievement)

(No. of Pupils = 379)

Scale Statistics

	Scale 1 (10 items) "Ecology"	Scale 2 (12 items) Population
Scale Mean	5.61	6.97
Scale Standard Deviation	1.97	2.72
Alpha Coefficient	0.57	0.72

Item Statistics

Item No.	Scale classification	Mean	Standard Deviation	Point biserial correlation with	
				Total score	Scale score
2	1	.90	.30	.55	.57
3	1	.40	.49	.41	.43
4	1	.63	.48	.38	.42
5	2	.63	.48	.41	.45
6	1	.85	.36	.47	.50
7	2	.80	.40	.57	.58
8	1	.18	.38	.22	.30
9	1	.60	.49	[illegible]	.54
10	1	.23	.42	[illegible]	.36
11	2	.67	.47	.56	.59
12	1	.79	.41	.49	.56
13	2	.28	.45	.34	.38
14	1	.64	.48	.45	.49
15	2	.59	.49	.50	.52
16	2	.78	.41	.64	.64
17	1	.39	.49	.31	.42
18	2	.71	.46	.59	.61
19	2	.60	.49	.46	.47
20	2	.59	.49	.43	.48
21	2	.20	.40	.21	.26
22	2	.43	.50	.36	.42
23	2	.69	.46	.46	.53

POST-TEST : HOW MANY PEOPLE

This is a test of your knowledge and understanding of some ideas about science and our environment. Here are a few suggestions which will help you earn your best score.

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C. the human body

D. the stars

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Your answers should be marked on page two of the answer sheet in this way. The question paper should not be marked.

DO NOT TURN OVER UNTIL YOU HAVE ANSWERED THE QUESTION BELOW.

1. On the first page of the answer sheet write down in no more than half a page what you think are the most important things you have learned in the science lessons on "How Many People".

Answer the following questions on the second page of the answer paper.

2. The process where both resources and waste products are reused continually is called:

A. consuming

B. biological control.

C. conservation

* D. recycling.

3. From a school with an enrolment of 600 pupils, the names of 35 were selected from a hat. These students were given an intelligence test and the average of the scores was taken as the school average. The group tested is called

* A. a sample

B. a class

C. a population

D. a census

4. Select the best answer from the ones which follow. A species consists of individuals which

A. possess a similar body structure to each other.

* B. interbreed and produce fertile offspring.

C. produce children who are the same as the parents.

D. possess a similar body colour to each other.

5. The source of energy for all living things is

A. chlorophyll

B. plants

* C. sunlight

D. water.

6. Which of the following could have a serious effect on the everyday ecological cycles?

A. denitrifying bacteria.

* B. chemical and industrial wastes in rivers.

C. use of fertilizers

D. animal wastes and decay.

7. Ecology is the study of

A. the pollution occurring in the natural environment

* B. living things in their natural environments

C. samples in oceanic and fresh water environments

D. the structure and function of nature

8. An estimate of the number of living things in a certain space is known as a

A. sample

B. model

* C. census

D. population

9. A factory which manufactures matches would most likely refer to wood, glue and phosphorus as

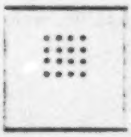
A. products

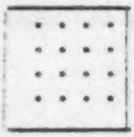
B. pollutants

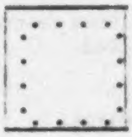
C. wastes

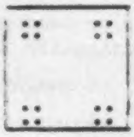
* D. resources

10. Each of the squares below represents a town with the factories (marked .) located as shown


A


B


C


D

If all factories produce the same amount of waste products each day then

* A. A has the greatest pollution problem

B. A, B, C & D have the same pollution problem

C. B has the greatest pollution problem

D. A and C have the same pollution problem.

11. The term population refers to

A. a number of individuals of several different species

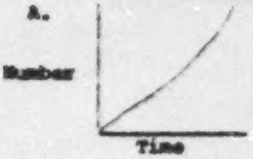
B. pairs of individuals of many different species

C. all the organisms living in a definite space

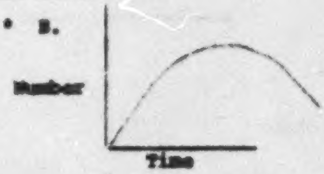
* D. all the organisms of one species living in a definite space

12. A growing population becomes limited by resources. Which of the following graphs represents this best?

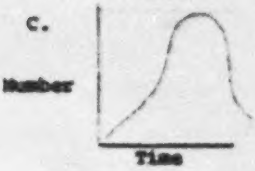
A.



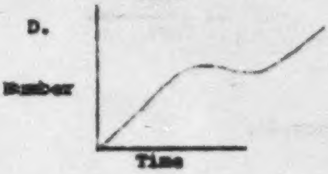
• B.



C.



D.



13. If waste products that are being formed are not recycled their quanitity would be expected to

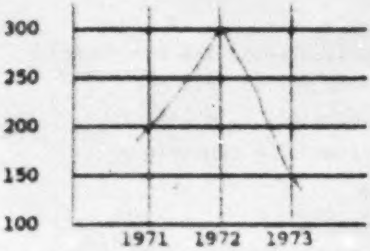
• A. accumulate

B. become exhausted

C. disintegrate

D. become biogradable

14.



The graph represents the population of a small town. What was the population change between 1971 and 1973?

A. +150

B. + 50

• C. - 50

D. -150

15. Which of the following factors would be least likely to decrease the size of a population of mullet fish in a section of the Brisbane River?

A. an increase in the number of people swimming in the river

B. the introduction of a different species of fish

C. the establishment of a housing development on one bank of the river

• D. using a small amount of water from the area for drinking purposes.

16. Which of the following would be least affected if the meat-eating animals were to suddenly increase in numbers.

A. plant-eating animals

B. bacteria and moulds

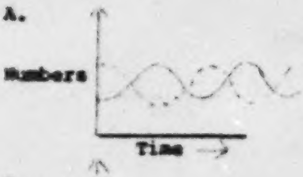
C. green plants

• D. the atmosphere

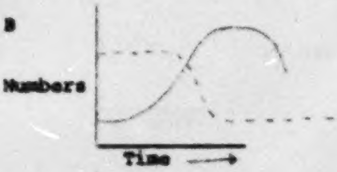
17. Which of the following graphs best represents the population changes over a period of three months when locusts invade an agricultural area?

——————— locusts ------------- crop

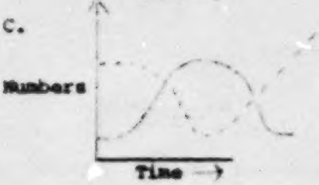
A.



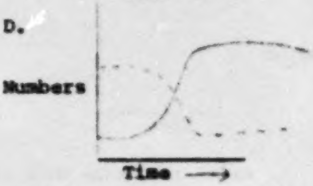
* B



C.



D.



18. If the sun were to continue to give out heat but stop giving out light, which group of organisms would be last to die out (become extinct)?

A. green plants

B. plant-eating animals

C. meat-eating animals

* D. bacteria and moulds

19. Where on the earth's surface would the concentration of carbon dioxide be highest? In the atmosphere immediately above

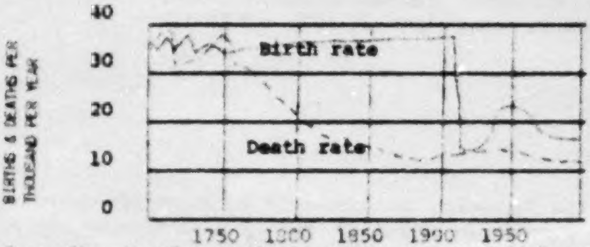
* A. a heavy industrial area set in a valley

B. a coal mine on the side of a mountain

C. a large forest area

D. a herd of cattle grazing

20.



According to the graph above the population increase was greater in the period between

A. 1750 - 1800

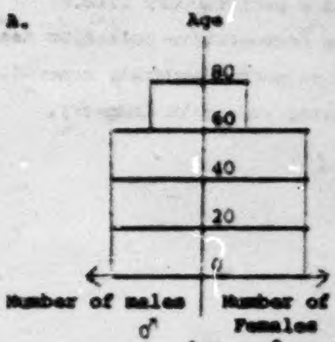
B. 1800 - 1850

* C. 1850 - 1900

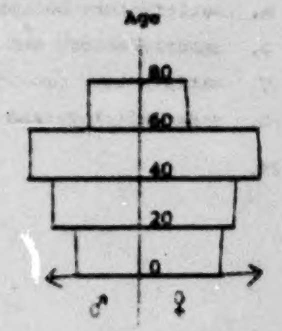
D. 1900 - 1950

21. Which of the following age-sex structures would most likely represent a rapidly increasing human population?

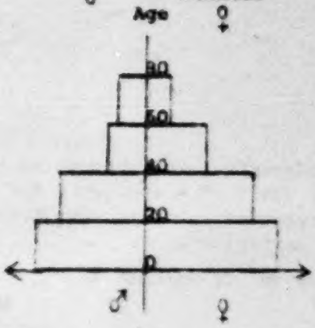
A.



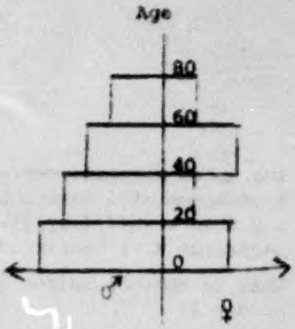
B.



* C.



D.



22. - 24

Read the following brief article and then answer questions Numbered 22, 23 and 24 which refer to it.

"A statement by Joan Best under the title of "Managed Forests" is not as extreme as those of some conservationists and technologists. Certainly people do require timber and shelter and materials for clothes and food. But at the same time, exploitation of our resources must be carefully and well managed.

We have created many social and environmental problems but so far we have only treated the symptoms, e.g. by adding smoke arrestors to chimneys and fluoride to drinking water. What we now need are long-term preventative measures.

Technology too will need to be well managed and will have to direct its energies to repair the damage it has done to the environment. Only then can man lead a more satisfying life".

22. How would you classify the author of the article? As

A. an extreme conservationist

B. an extreme opponent of technology

* C. a moderate conservationist

D. a supporter of technology

23. The author hopes that the people of the future will

* A. direct their energies to solving pollution problems

B. gain benefit and satisfaction from a repaired environment

C. be very little different to the people of to-day

D. have shelter, clothes and food for all.

24. According to the author the present environmental situation of man is

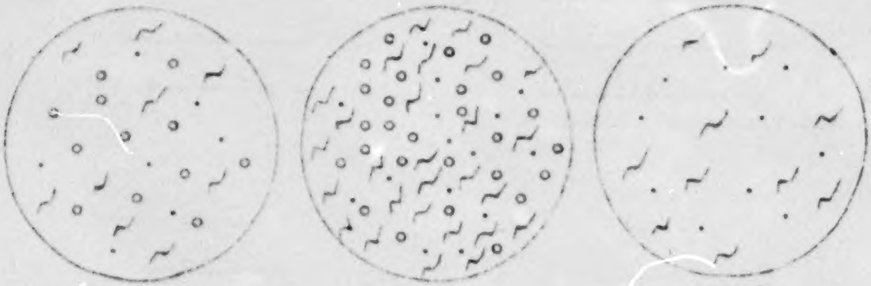
A. satisfactory because man can lead a satisfactory life.

* B. unsatisfactory and requiring more preventative pollution measures.

C. satisfactory provided technology is more adequately controlled.

D. unsatisfactory and requiring greater repair to industry.

25 - 28.



Day 1 Day 2 Day 3

The above diagrams represent photographs taken through an electron microscope of a square millimeter (mm^2) of a sock worn for two days and then washed (day 3). Three types of bacteria were observed: Bacterium X ~ ; Bacterium Y . ; Bacterium Z o.

25. What is the population density per mm^2 of species X on day 3?

A. 21 * B. 11 C. 9 D. 33

26. The most accurate measure of the population of series Z on the sock for day 1 would be obtained by:

A. counting the number of circles like o in the diagram.

B. inventing a device for sampling and using this to estimate the population

* C. using the count in A and multiplying by the area of the sock

D. using the estimate in B and multiplying by the area of the sock.

27. Which species is most sensitive to the influence of extreme environmental changes

A. X

B. Y

C. Z

D. the species are equally affected.

28. What is the population of species Y on the area photographed on day 3?

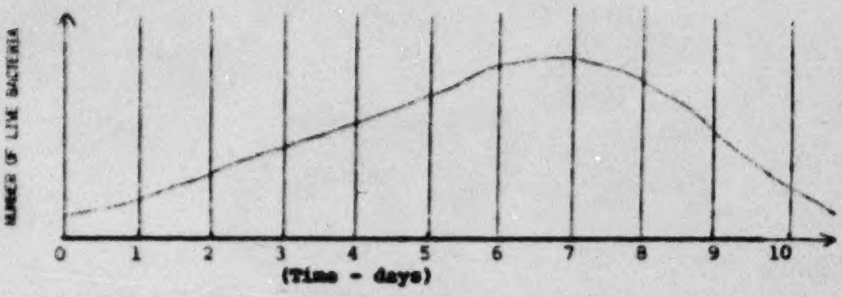
A. 0

* B. between 1 - 10

C. between 11 - 20

D. more than 20.

29.



Of the following statements, which ones, if any, are supported by the graph?

A. bacteria reproduce faster than fungi

B. the size of a population is limited by the food available

* C. there is a rapid increase in the number of bacteria from day 2 to day 4.

D. after 12 days the numbers of bacteria have rapidly decreased.

30. If in a given population of crocodiles in Northern Australia, the amount of food was suddenly increased permanently to a higher level the population would:

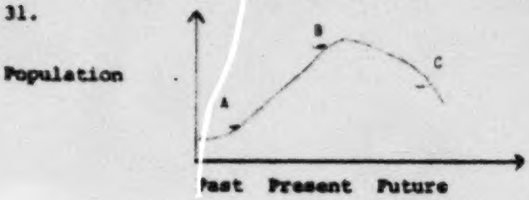
A. remain the same as it was before

B. increase rapidly and then die out

* C. eventually increase and then level out

D. decrease initially and then increase.

31.



The above graph shows a biologists impression of the past, present and future of human population. Which of the following statements derived from the graph is least well supported by available evidence?

A. man's population originally was small and increased at a slow rate

B. the "population explosion" is represented by the portion A to B.

* C. in the distant future, man will become extinct

D. the progress of man's population has not yet reached point C.

ITEM STATISTICS FOR POST-TEST

(Criterion Achievement)

(No. of pupils = 382)

Scale Statistics

	Scale 1 (12 items) "Ecology"	Scale 2 (18 items) Population
Scale Mean	6.47	7.27
Scale Standard Deviation	2.88	3.57
Alpha Coefficient	.77	.77

Item Statistics

Item No.	Scale classification	Mean	Standard Deviation	Point biserial correlation with	
				Total score	Scale score
2	1	.82	.39	.72	.72
3	2	.55	.50	.58	.61
4	1	.15	.36	.15	.23
5	1	.78	.41	.72	.73
6	1	.75	.43	.64	.64
7	1	.62	.49	.47	.50
8	2	.55	.50	.50	.53
9	1	.64	.48	.65	.66
10	1	.25	.44	.28	.38
11	2	.57	.50	.57	.59
12	2	.46	.50	.47	.49
13	1	.66	.47	.64	.64
14	2	.66	.47	.62	.63
15	2	.28	.45	.32	.34
16	2	.31	.46	.34	.38
17	2	.21	.41	.22	.26
18	1	.61	.49	.51	.56
19	2	.53	.50	.46	.48
20	2	.57	.50	.45	.45
21	1	.38	.49	.36	.42
22	1	.42	.49	.45	.47
23	1	.39	.49	.32	.41
24	2	.57	.50	.50	.50
25	2	.68	.47	.67	.66
26	2	.33	.47	.33	.35
27	2	.56	.50	.59	.62
28	2	.22	.41	.23	.27
29	2	.21	.41	.28	.33
30	2	.63	.48	.56	.58
31	2	.29	.45	.29	.25

' D '

PRE AND POST ATTITUDE TESTS

ATTITUDE TO SCIENCE AND TO SCIENCE LESSONS
PRE - TEST

THERE ARE SOME STATEMENTS ON THE NEXT PAGES ABOUT SCIENCE, SOME OF THE ISSUES WITH WHICH SCIENCE AND MANKIND ARE INVOLVED AND ABOUT YOUR SCIENCE LESSONS.

AFTER YOU HAVE READ A STATEMENT YOU ARE ASKED TO DECIDE WHETHER OR NOT YOU AGREE WITH IT. IF YOU AGREE, DECIDE WHETHER YOU AGREE MILDLY, OR STRONGLY. IF YOU DISAGREE, DECIDE WHETHER YOU DISAGREE MILDLY OR STRONGLY.

Here is an example:

0.0 I would like to have a lot of science lessons.

Now, on your answer sheet you would black out, or place a cross over the number -

5. if you agree strongly
4. if you agree mildly
3. if you neither agree or disagree.
2. if you disagree mildly
1. if you disagree strongly

PLEASE RESPOND TO EACH STATEMENT AND BLACK OUT OR CROSS OUT ONLY ONE NUMBER FOR EACH STATEMENT.

STATEMENTS.

1. Pollution of the sea is becoming a major problem.
2. Australia's population should not be allowed to concentrate in capital cities.
3. Brisbane city is not greatly affected by pollution.
4. The rate of births must be controlled to set some limits to population growth.
5. Insect pests must be controlled with insecticides.
6. In our growing population many more mental health hospitals will be needed.
7. The people of Brisbane should be prepared to pay higher rates for improved sewage treatment plants.
8. Australia's population should be limited to 13 million people.
9. There should be harsher penalties for people who litter the countryside.
10. Man must limit the size of his population for his own good.
11. Dangerous quantities of wastes are accumulating on earth due to man's neglect.
12. The rapid growth of human population is a major threat to man's survival.
13. We must accept the fact that resources must be consumed at a rapid rate.
14. It would be simpler to burn waste paper than to go to the bother of collecting it for reuse.
15. We have adequate resources on earth to support our steadily growing population.
16. Much more money needs to be spent on finding ways of recycling manufactured products.

17. The using up of natural resources is a severe threat to life in Australia.

18. Because man can use technology to increase food production there is no need to control the size of the world's population.

19. I like working in small groups in science lessons.

20. I have learned a lot of interesting and useful things in science.

21. I am not interested in learning about science.

22. Science is one of my favourite subjects.

23. I feel hopelessly lost in science lessons.

24. Science is a worthwhile subject to study.

. . . .

ITEM STATISTICS FOR ATTITUDE SCALE

PRE - TEST

(No. of Pupils = 379)

Scale Statistics

	Scale 1 (6 items) "Pollution"	Scale 2 (7 items) "Population"	Scale 3 (5 items) "Resources"	Scale 4 (6 items) "Science Lessons - Interest
Scale Mean	21.77	23.82	17.69	22.16
Scale Standard Deviation	3.65	4.76	3.42	4.97
Alpha Co-Efficient	0.42	0.67	0.43	0.77

Item Statistics

Item No.	Scale Classification	Mean	Standard Deviation	Point biserial correlation with Total score	Scale Score
1	1	4.22	1.00	0.42	0.54
2	2	3.39	1.15	0.45	0.50
3	1	3.37	1.31	0.33	0.57
4	2	3.49	1.29	0.54	0.72
5	1	2.91	1.35	0.26	0.39
6	2	3.42	1.03	0.28	0.38
7	1	2.97	1.30	0.18	0.36
8	2	2.31	1.21	0.09	0.37
9	1	4.05	1.13	0.50	0.63
10	2	3.77	1.17	0.60	0.74
11	1	4.25	1.07	0.63	0.61
12	2	3.63	1.13	0.64	0.74
13	3	2.94	1.23	0.18	0.46
14	3	3.52	1.39	0.38	0.59
15	3	3.59	1.28	0.50	0.62
16	3	4.14	1.09	0.50	0.55
17	3	3.50	1.17	0.42	0.55
18	2	3.82	1.20	0.56	0.59
19	4	3.99	1.81	0.43	0.47
20	4	3.61	1.26	0.53	0.76
21	4	3.96	1.17	0.56	0.75
22	4	3.13	1.30	0.42	0.71
23	4	3.48	1.26	0.42	0.65
24	4	3.99	1.11	0.59	0.76

ATTITUDE TO SCIENCE AND TO SCIENCE LESSONS

POST-TEST

THERE ARE SOME STATEMENTS ON THE NEXT PAGES ABOUT SCIENCE, SOME OF THE ISSUES WITH WHICH SCIENCE AND MANKIND ARE INVOLVED AND ABOUT YOUR SCIENCE LESSONS.

AFTER YOU HAVE READ A STATEMENT YOU ARE ASKED TO DECIDE WHETHER OR NOT YOU AGREE WITH IT. IF YOU AGREE, DECIDE WHETHER YOU AGREE MILDLY OR STRONGLY. IF YOU DISAGREE, DECIDE WHETHER YOU DISAGREE MILDLY OR STRONGLY.

Here is an example:

0.0 I would like to have a lot of science lessons.

Now on your answer sheet you would black out, or place a cross over the number

5. if you agree strongly.
4. if you agree mildly
3. if you neither agree or disagree
2. if you disagree mildly
1. if you disagree strongly.

PLEASE RESPOND TO EACH STATEMENT AND BLACK OUT OR CROSS OUT ONLY ONE NUMBER FOR EACH STATEMENT.

STATEMENTS.

1. In our expanding population many more mental health hospitals will be needed.
2. The ocean around Australia can still be used for the disposal of cans, bottle and sewage.
3. We have adequate resources on earth to support our steadily growing population.
4. The size of families should be limited.
5. Country centres such as Longreach, Cloncurry have no pollution problems.
6. Adequate care is exercised in Australia with use of insecticides.
7. I would like to see Brisbane's population reach a million.
8. Those who agree that we should use birth control pills and other measures to limit the size of families show no respect for human life and human rights.
9. I would be prepared to pay a cent or two more for soft drinks if the money were used to ensure that litter (cans, bottles, etc.) caused by them were cleaned up.
10. The using up of national resources is a severe threat to life on earth.
11. It would be simpler to burn waste paper than to go to the bother of collecting it for re-use.
12. Australia's population should be distributed more evenly along the east coast of the country.
13. We must accept the fact that resources must be consumed at a rapid rate.
14. Much more money needs to be spent on finding ways of recycling manufactured products.
15. Students at this school who litter the area around the school should be severely penalised.
16. The rapid growth of human population is a major threat to man's survival.

17. Dangerous quantities of wastes are accumulating on earth due to man's neglect.

18. Because man can use technology to increase food production he can cope with increases in the world's population.

(The following statements are about the science lessons on (How Many People) you have taken recently)

19. The unit "How Many People" was not very interesting.

20. The lessons were too noisy for us to do anything worthwhile.

21. The lessons helped me to like science much more then before.

22. I did not like working in the small groups.

23. Our teacher was able to give me more help in these lessons than in our usual ones.

24. The lessons were too dry and boring for me.

25. I learnt more in these lessons than in our usual ones.

26. The thing I liked best was the freedom we were given to do the work.

27. I would not like to use more parts of the A.S.E.P. science course this year.

28. The activities and experiments helped me to understand more.

29. I learned a lot of interesting and useful things in the unit on How Many People.

30. The lessons seemed to make science more interesting.

31. I tried several of the activities in the A.S.E.P. unit at home.

32. The activities and experiments weren't very interesting.

33. I did more work in these lessons than my usual science ones.

34. I liked doing the experiments with some of my classmates.

35. I liked being able to talk about the work with my group.

36. These lessons were the most enjoyable I have ever done at school.

. . . .

ITEM STATISTICS FOR ATTITUDE SCALE

POST-TEST

(No. of Pupils = 382)

Scale Statistics

	Scale 1 (6 items) "Pollution"	Scale 2 (6 items) "Population"	Scale 3 (6 items) "Resources"	Scale 4 (8 items) "Science Lessons Interest"	Scale 5 (6 items) "Learning"	Scale 6 (4 items) "Lesson Organisation"
Scale Mean	22.56	21.78	21.78	27.02	20.90	15.71
Scale Standard Deviation	3.96	3.97	4.02	6.76	4.97	3.55
Alpha Coefficient	0.63	0.57	0.59	0.83	0.78	0.79

Item Statistics

Item No.	Scale Classification	Mean	Standard Deviation	Point biserial correlation with	
				Total score	Scale score
1	2	3.68	1.02	0.29	0.50
2	1	4.27	1.56	0.47	0.65
3	3	3.72	1.77	0.45	0.66
4	2	3.49	1.20	0.39	0.61
5	1	3.27	1.06	0.23	0.42
6	1	3.33	1.12	0.38	0.51
7	2	3.83	1.21	0.44	0.52
8	2	3.48	1.38	0.30	0.58
9	1	3.95	1.13	0.45	0.64
10	3	3.91	1.14	0.54	0.67
11	3	3.66	1.29	0.39	0.63
12	2	3.29	1.09	0.21	0.45
13	3	2.90	1.21	0.07	0.35
14	3	4.07	1.10	0.53	0.56
15	1	3.65	1.11	0.40	0.61
16	2	4.02	1.13	0.60	0.71
17	1	4.08	1.12	0.60	0.71
18	3	3.51	1.11	0.37	0.57
19	4	3.55	1.25	0.64	0.74
20	5	3.71	1.15	0.61	0.58
21	4	3.32	1.18	0.48	0.63
22	6	3.88	1.20	0.61	0.79
23	5	3.35	1.32	0.40	0.60
24	4	3.51	1.27	0.66	0.78
25	5	3.23	1.23	0.49	0.75
26	6	3.83	1.20	0.54	0.73
27	4	3.63	1.31	0.61	0.73
28	5	3.65	1.15	0.64	0.74
29	5	3.63	1.11	0.65	0.76
30	4	3.61	1.24	0.68	0.81
31	4	2.63	1.29	0.14	0.39
32	4	3.61	1.19	0.62	0.70
33	5	3.33	1.25	0.49	0.71
34	6	4.00	1.05	0.65	0.80
35	6	3.99	1.08	0.66	0.82
36	4	3.15	1.23	0.51	0.67